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RADC/EEV DIAGNOSTIC RHYME TEST SYSTEM IMPROVEMENTS

ARCON Corporation

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This report fully documents the current Diagnostic Rhyme Test (DRT) System used at RADC/EEV for the test and evaluation of the intelligibility of digital voice communication systems.

All improvements to this system are presented in detail. This report is structured to serve both as a guide for the use of the DRT system and as a reference for modification of the software or for conversion of the software to another facility.

This report documents four special projects that are associated with the DRT system. A modification to the DRT that allows for the measurement of the intelligibility of systems that are heavily affected by transmission drop-outs or bursts of transmission errors is presented. A method and system for performing the DRT at Field sites is given. This method includes software for the presentation of test words to the speaker and the collection of listener response data. The ability to repeat partial sections (Continued on reverse)

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of a test is provided. The procedures used for the generation of the DOD Digital Voice Processing Consortium DRT/DAM Digital Master Library are given. This master library of source material for DRT/DAM testing of voice communication systems is discussed. Contents of the library are provided.

CONTENTS

CHAPTER 1

DIGITAL SPEECH COMMUNICATIONS TEST AND EVALUATION OVERVIEW

1.1 LISTENER TEST AND EVALUATION - DIAGNOSTIC RHYME TEST (DRT)

The Department of Defense has selected the DRT (Refs. 1 - 3) as the standard test for intelligibility of digital voice communication systems. This test method has been used by the DoD Digital Voice Processing Consortium for the past ten years as the primary measure of intelligibility of secure digital communication systems. RADC/EEV, NRL, NSA, DCA and many others have also used the DRT as an aid to their individual efforts in speech compression research. NSA has selected the DRT as the final measure of intelligibility for the Future Secure Voice Program and as a selection procedure for the STU III contractor. All of this interest stresses the importance of the DRT.

Independent DRT measures are available from Dynastat Corp. of Austin, TX. Several years ago the AF saw the need for a government controlled implementation of the DRT to serve as a second source of testing and as a means of verifying the test's repeatability and accuracy. This RADC/EEV implementation of the DRT is detailed in Reference 4.

ARCON Corporation has been heavily involved in the in-house DRT program at the RADC/EEV Speech Processing Facility since its inception. ARCON has been responsible for conducting and administering the DRT sessions for eight years. The scoring, reporting and analysis software for the DRT results have all been developed by ARCON personnel. Several new analysis tools have been designed and implemented by ARCON. The ability to measure the intelligibility of communication systems corrupted by random burst errors that totally disrupt a transmission channel has been provided by ARCON to RADC/EEV through the development of a modified DRT method and scoring procedure. The introduction and validation of a method to equalize the presentation level of DRT input tapes to voice processors based on Equivalent Peak Levels is an example of ARCON's expertise in this field. The modernization of DRT data collection with the introduction of a TRS-80 M100 Data Entry System was conceived, designed, implemented, tested and verified by ARCON personnel. The development of software for these efforts can be followed through ARCON reports, References 5 - 7.

This report will cover improvements to the RADC/EEV Test and Evaluation System and several special projects that were completed during the period of contract F19628-86-C-0057 (15-February-1986 to 24-June-1988). Numerous software packages are discussed within this report. Source code for most of these programs is available directly from RADC/EEV. Any requests should be addressed to the technical contract monitor, Mr. Luigi Spagnuolo. A copy of this report and all source, taskbuild and overlay files required to generate tasks for these programs are available on the RADC/EEV PDP-11/44 in virtual disk DRTDEV.

1.2 RADC/EEV DRT SYSTEM DATA BASES AND SOFTWARE

This report will discuss all modifications and additions made to the DRT System by ARCON during the current contract period. Chapter Two will discuss the DRT Data Base structures and give details on the latest version of the DRT Analysis Data Base (DB). The BASIC program DRT that runs on the Tandy M100 Data Entry Units for presentation of the DRT to the Listener Crew along with the programs COM and MODEL for transfer of raw DRT listener responses to the PDP-11/44 have not been changed during this contract period and will not be discussed. Details of these programs can be found in References 6 and 7. Chapter Three will discuss modifications to the Fortran program DRT that scores the DRT data and adds DRT systems to the comparative analysis DB. Numerous modifications and additions have been made to the DRT Comparative Analysis Package MENU. Chapter Four will provide full details on these changes. Chapter Five will complete the discussion on software changes with details on the DB utility packages. This chapter will introduce the new program GENDB that allows for the generation of special probe data base volumes.

1.3 SPECIAL PROJECTS

Interrupted Voice Communication Systems - The use of the DRT for the measurement of random channel effects has a limitation associated with periodic presentation of the information being tested (i.e. the leading consonant of the rhyming word). This limitation could be severe for tests measuring burst bit error and packet loss-effects. Intelligibility of continuous messages could be very different from that measured by the DRT. A modification of the DRT method has been developed, implemented and tested by ARCON for the evaluation of these "interrupted" communication systems. Software modifications to the RADC/EEV DRT System that allow for the testing of interrupted systems are discussed in Chapters Two through Five. The development of the interrupted system testing methodology and the validation of this method are covered separately in Chapter Six of this report.

In-Field Diagnostic Rhyme Testing - ARCON originally proposed the idea of an In-Field DRT capability in a March-84 memo to RADC/EEV. It detailed some ideas for an In-Place DRT Procedure using the TRS80 M100 Data Entry Units. The test method was suggested for use with the ESD ANDVT evaluation to be held that summer. The idea was well received by ESD and RADC/EEV management, and the project was officially started at an April-84 meeting with ESD.

Requirements for the full In-Field DRT System were supplied by ARCON including software and analog recording equipment. Procedures were designed for the use of in-house ESD and RADC personnel as listeners and speakers. Training procedures were developed and carried out with these individuals. An in-field set of training procedures were developed for use with operational personnel. These procedures were augmented with an audio ANDVT DRT Training Tape developed by ARCON. All the required software was developed by ARCON, the test equipment was acquired, base line data was collected in-house and actual field data was collected by the RADC and ESD team. Validation measures on this effort proved inconclusive due to numerous problems with the field collection of data.

Documentation of the method, equipment, training procedures, and software developed for the In-Field DRT is provided for the first time in Chapter Seven of this report.

DRT/DAM Digital Mastering Project - ARCON has been involved in a joint RADC/EEV and DoD Digital Speech Processing Consortium effort to digitally master the DRT/DAM test material for the past five years. The procedures and equipment used in this effort are documented in Chapter Eight of this report. A complete listing of the new digital master library is provided as an appendix to this report.

1.4 ACKNOWLEDGEMENTS

The authors wish to acknowledge the cooperation, encouragement, and technical support received from Mr. Anton Segota, Mr. Luigi Spagnuolo, and 1st Lt. Denis Robitaille of RADC/EEV. Capt. Mark Gervais of RADC/EEV developed and implemented a new method of transferring data between the Data Entry Units used for the DRT. He was also responsible for clearing up several addressing problems with the Field and In-house DRT data collection software. Mr. C.P. Smith of RADC/EEV directed the digital mastering of the DRT and DAM test material. He was also involved in the field measurements of intelligibility and the measurement of intelligibility for interrupted voice communications channels.

Mr. James T. Sims provided all the software development for the interrupted DRT while employed by ARCON. He was responsible for the design and implementation of the ANOVA analysis package and the GENDB routine. Mr. Sims' notes and memos were used extensively in compiling this report. Mr. Sims was involved with Mr. Gatewood in the development of procedures used in the DRT/DAM mastering effort and was responsible for the development and implementation of the level equalization and speech to noise algorithms. The authors also wish to acknowledge the support provided by the DoD Digital Voice Processor Consortium Test and Evaluation Committee to the digital mastering effort.

CHAPTER 2

RADC/EEV DIAGNOSTIC RHYME TEST DATA BASE STRUCTURE

When a DRT session is administered, the raw input data is transmitted from the Radio Shack TRS-80 Model-100 Portable Computers, which are used by a DRT listener crew for the entry of a DRT booklet set, to a raw data file located on the PDP-11/44 DRT account at RADC/EEV. This raw data file is given a file name in the form NNNN.ZFY;VV, where NNNN will be the previously assigned system number and VV will be a version that distinguishes more than one testing of the same system audio tape. All these NNNN.ZFY files make up the DRT Raw Data Base (DB) and reside either on the DRT account on the PDP-11/44, on a backup device BK:, or on archived RL02 disks. The structure of these files has not been modified and is fully detailed in Reference 7.

The routine DRT takes data stored in the DRT Raw data base, generates scores (i.e., percentage of words correctly recognized), processes these scores into reports, and if requested, stores the processed data on another DB known as the DRT Analysis Data Base. The addition of a processed DRT system to the DRT Analysis DB allows for comparison of that system to any other in the DB. The data bases are found on virtual disk volumes stored primarily on the CDC 300 Mbyte disk drive at the RADC/EEV Speech Facility and can be accessed by mounting the virtual disk assigned to the DB requested.

A detailed description of the DRT analysis data base structure along with two special modifications to this structure are presented in the following sections.

2.1 DRT ANALYSIS DATA BASE STRUCTURE

The "Data Base Disks" are setup to contain a series of 100 systems (i.e., 2400 to 2499 on 2400 DB disk) and up to 200 total repeat tests of systems. A DB disk can be set up using the program DBTILTY which will be described in a later section.

Each DB disk contains three unformatted direct access files that allow individual records to be read. The files are DB.INX, DB.HDR, DB.DAT as defined in the assign and define file statements below.

```
CALL ASSIGN (1,' DB:DB.INX ')
CALL ASSIGN (2,' DB:DB.HDR ')
CALL ASSIGN (3,' DB:DB.DAT ')
DEFINE FILE 1 (     3, 200, U, IAV)
DEFINE FILE 2 (   300, 100, U, IAV)
DEFINE FILE 3 ( 21600,  20, U, IAV)
```

DB.INX provides a record of all systems present on the DB and any repeat systems by transferring this record information into three arrays, IDDISK, INDEX, and IOVFLO. The IDDISK array holds the two system numbers that define the range of the DB and is primarily used as a data base flag. In other words, the routine can tell whether the DB assigned to DK2: or DK3: is an original probe disk, an expanded probe disk, a generic probe disk, or a system data disk simply by checking the values stored in IDDISK. The INDEX array holds the first version numbers of the 100 systems and the total number of higher versions that each system has on that DB. The IOVFLO array holds the higher version system number for up to 200 repeat tests.

DB.HDR contains header records for each of the maximum 300 systems on the DB. The DB.DAT file has 21600 records of 40 bytes, each record being directly readable. Each record contains the 36 bytes that define the results of a DRT Booklet (i.e., listener*speaker interaction). The 36 bytes represent six features*three subfeatures*two states(P/A) = 36. Note that although the main feature result is a function of the subfeature results, it is given separately. This keeps the data compatible with previous work.

The 21600 records of DB.HDR represent 12 listeners*6 speakers*300 systems = 21600. The position of the particular system number and its version in INDEX or IOVFLO acts as a pointer to the location in DB.DAT from which the record for that system should be read from. Read and write procedures and data formats can be clarified by checking the code in subroutine ADDDB of program DRT and the program package MENU.

2.1.1 Interrupted DRT System Data Base Structure

The development of a modified DRT procedure for the intelligibility testing of "interrupted" communication systems is covered in Chapter 6. It was decided that these systems should reside in the existing DRT analysis DB. This would allow for the comparative analysis of these systems with all other DRT systems in the DB. These systems require the storage of additional information. For "interrupted" systems all test words are not scored, therefore the number of measures for each feature is not always the same. The actual feature test item counts must be saved in the DB. Since interrupted DRT systems are added to DRT DB and scored in a similar manner as regular DRT's, a need for distinguishing between the two types is also necessary.

ARCON solved the problem of distinguishing between systems with the introduction of the interrupted system flag stored in the unused portion of each system's header. We also employed the unused portion of the header to store the test item count values so they could be retrieved for analysis purposes.

The unused elements of the IHEAD array (from the system's DB.HDR file) are used to record the interrupted system flag and the test item count values. IHEAD (52) is a flag to indicate whether the system is interrupted (-1) or non-interrupted (not -1). Thus compatibility with the previous non-interrupted systems should be maintained. Each count value can range from 0 to 8 as only the four subfeatures by P/A categories are recorded for each feature. (Note the number of test items for a "main" feature category is the sum of two subfeature counts.) These values are packed in 4-bit structures ordered first by speaker and then by feature just like the actual DRT data. A total of 6 * 6 * 4 = 144 values are recorded in 36 elements of IHEAD beginning at IHEAD(53).

2.1.2 Expanded Probe Data Base Structure

A probe system is a system run at the start of every DRT session and is used to monitor listener and soundroom performance. An Expanded Probe Disk structure was created to allow for more probes to be stored on an individual disk. Since the probe system is the same every time it is run, system numbers and higher versions have no significance to a Probe DB. Probe disks are identified with having system numbers starting at 9000. A new "expanded" probe data base was created that did not change the structure of the data base but only changed the way data would be entered.

Expanded probes have 300 version 1 systems on a DB where as original probes have 100 version 1 systems with space for 200 repeat tests of the same probe system (i.e. higher versions). Each expanded probe disk is made up of the three unformatted direct access files, DB.INX, DB.HDR, and DB.DAT, as described above. Yet in the expanded probe the file DB.INX is used differently for the storage of system numbers. System numbers on an expanded probe disk range from 9000 to 9299. The two arrays in DB.INX, INDEX and IOVFLO, are interpreted differently since they are all version 1 systems. The INDEX array now holds the first 100 probe systems, namely 9000 to 9099, with the total number of higher versions of those systems which should all be set to zero since there are no higher versions on an expanded probe. The IOVFLO array allows for 200 more probe systems, namely 9100 to 9299. This Expanded Probe DB structure has required changes to the scoring program DRT, the analysis package MENU, and the DB utility routine DBTILTY.

2.1.3 Generic Probe Data Base Structure

The Probe DB allows for the study of system changes over time (i.e., DRT scores as a function of a Probe repetition). In order to provide the capability of studying DRT scores as a function of other variables for any set of DRT systems, the Generic Probe Data Base (GPRB) was devised. Its structure is identical to the Expanded Probe DB and is identified by the first system number 9600. The analysis routines of the MENU package have been modified to recognize a GPRB DB and treat the systems accordingly.

The analyst can design a test series that varies a single parameter or pick from existing systems in the overall DB to generate a GPRB volume ordered on whatever parameter he wishes to study. The program GENDB (see Chapter 5) allows the analyst to interactively build a GPRB sequential analysis volume. The probe analysis routines of MENU are then used for study of the data. Since no Probe systems can have more than one version, the 9600 systems are referenced by the systems numbers 9600 to 9899. The software has been modified to use the original system numbers for all labels and/or figure headers.

2.2 DRT DATA BASE BACKUP PROCEDURES

Diagnostic Rhyme Test raw data files and the DRT Data Base used for comparative analysis require separate backup steps. These procedures have been automated within the login DRT/BACKUP. By properly answering all questions and by loading DL0:, DL1:, DL2:, or DL3: with the proper RL01/RL02 backup disk, both the raw data files and the DRT Data Base can be backed up or restored easily. Backup volumes for all DRT Data Bases and the .ZFY raw data files reside in the Disk Storage cabinets of the RADC/EEV Speech Processing Facility at Building 1120.

CHAPTER 3

DIAGNOSTIC RHYME TEST SCORING

The program DRT is used for scoring input data from DRT test sessions. It has been described in detail in numerous reports (Ref. 7). The input data is transmitted from the Radio Shack TRS-80 Model 100 Portable Computers, used by a DRT listener crew for the entry of DRT word choices, to a data file located on the PDP-11/44 DRT account by the program MODEL (Ref. 5). The data files are named in the form NNNN.ZFY;VV, where NNNN will be the previously assigned system number and VV will be a version that distinguishes more than one testing of the same system audio tape.

The program DRT takes data stored in NNNN.ZFY files, processes it into reports, and if requested, stores the processed data in the appropriate updated Data Base Disk. The user specified inputs required for this software module include the particular .ZFY file and its version. The other input file required by DRT resides on the pseudo device DF: and is called COMKEY.KEY which contains the DRT wordlist keys. If scoring interrupted systems, DRT requires that the input file NNNN.KEY, which contains a missing word key for the interrupted system, reside on the psuedo device DF:.

DRT produces two optional reports. The first report consists of: individual listener feature scores averaged across speakers, individual speaker feature scores averaged across listeners, and final feature scores averaged across listeners and speakers. The second report is a listing of the "reordering" process to reduce the number of listeners to a base set of eight. This report includes a matrix of listener by speaker total scores averaged across features and states (present and absent); listener deviation from the speaker means and variance in this deviation; a multivariate F-statistic analysis for outliers; and a list of listeners reordered based on the largest variance. DRT also allows the user to add the current system to the appropriate DB disk. The routine checks for certain problems such as extremely low scores that may indicate a wrong wordlist key given and allows the user to correct it before the addition to the DB.

During the current contract period several modifications have been made to the DRT program. The following sections will discuss these changes. The source code for this latest version of the DRT program is available from RADC/EEV.

3.1 DRT MODIFICATION FOR STANDARD LISTENER SET

The subroutine MATR was modified to standardize when a base set of listeners is calculated. This is the routine that reduces or "culls" the number of listeners for a system to a standard set of eight. MATR calculates listener and speaker results averaged across all features and states along with deviations of these results from speaker means across listeners. MATR then takes these deviations and calculates the variance across speakers and an F-statistic for each listener. MATR then reduces the number of listeners to a base set of eight by reordering those listeners having the largest variance at the end of the list. This process was previously optional, it is now standard with the report of the process being optional.

3.2 DRT MODIFICATION FOR EXPANDED PROBE DB

The final modification to DRT was the revision of code to handle the addition of Probe systems to a new "expanded" probe disk. Original probe disks were set up just like system disks except that the system numbers ranged from 9000 to 9099 meaning that the probe disk could have 100 systems with up to 200 total repeat tests of those 100 systems. Yet, all probes are the same system run every test session, so there was no real need to have higher versions of the same system. Since this fact was evident, the introduction of "expanded" probe disks came along and their structure will be discussed further in Chapter 3. The subroutine ADDDB was the only subroutine in the DRT program to undergo changes due to this modification. ADDDB was modified to handle the addition of probe systems to the DB differently from the way data systems are added. Instead of checking for new versions or multiple versions of a system, it just finds the last system number on the data base, increments the system number, and transfers the data in the appropriate space. The DB.INX file of the "expanded" probe data base (discussed further in Chapter 3) is one of the major differences between the original probe disk and the expanded probe disk.

3.3 DRT MODIFICATION FOR INTERRUPTED SYSTEMS

The DRT task used for scoring raw input data for DRT sessions has been revised to permit the scoring of "interrupted" systems in which known DRT words are not presented to the listeners due to disruptions of the communications channel. Percentage correct scores are generated on the basis of the number of test items actually presented to the listeners.

A decision as to whether test items are present or not must be made by an administrator and recorded in a separate file DF:NNNN.KEY, where NNNN is the DRT system number. The development approach to Interrupted DRT's and its verification are covered fully in Chapter 6.

When the DRT task begins, the user is asked if he wishes to process a regular DRT, an interrupted DRT, or exit the program. Once the user answers the question, the routine continues and branches to its appropriate calls. During the execution of interrupted systems, counts of the number of test items for each of the Subfeature by P/A interactions is maintained based upon the data from the NNNN.KEY file. Instead of always dividing the number of correct responses (corrected for guessing) by a fixed constant as is done for regular DRT systems, the count of items actually presented serves as the divisor when creating a percentage correct score. Since interrupted DRT systems are added to the DRT data base and scored in a similar manner as regular DRT's, a need for distinguishing between the two types of DRT systems and a location to store these count values was necessary. Therefore, DRT was revised to handle the addition of an interrupted system flag. This interrupted system flag allows the analysis program to recognize what type of system it is working with. It is either set to -1 if the system was an interrupted DRT or not -1 for a regular DRT. The structure of interrupted systems in the DB is discussed further in Chapter 2.

3.3.1 Procedures For Identifying Missing DRT Words

Processed DRT tapes are monitored with headphones in a quiet environment. Words containing errors can be played back numerous times. Due to the nature of the DRT, being a first consonant dependent test, the decision of whether the word is good or obliterated is defined by whether the first consonant is obliterated. In most cases this decision comes easily as the entire word, or sometimes a string of words, is completely wiped out, either by errors or by the mutes that occurred directly after large concentrations of errors. In the cases of words that remain partially intact, playback is repeated more often. If an audible artifact, one not easily attributed to processor under test, is detected in the first consonant, the word is considered obliterated. The channel errors seen over these communications systems caused large, momentary spikes in level making them easy to differentiate from the anomalies of most processor algorithms. Words that have an intact first consonant, even if errors are within the remainder, are considered good. Words considered to be at zero intelligibility are marked off on a DRT test booklet (RADC Form 108) and the number representing where they fall on the page (1-58) is marked. These forms are then used to generate interrupt keys for the scoring procedure using the program INTKEY.

Interrupted Word Key - A utility INTKEY was implemented to provide a means of generating interrupt key files, NNNN.KEY, needed for the program DRT. The program INTKEY begins by requesting the user to enter the number of the file on DF: for which this routine is creating a key and the number of speakers in the system to be scored. Since each DRT booklet has four pages with 58 words on a page, the program INTKEY requests the missing word number(s) 1 to 58 one page at a time. The user is allowed to repeat the page he is currently on at any time by hitting a control Z which will wipe out what was entered previously for that page. This process of entering numbers page by page continues until the number of speakers entered by the user at the start of the routine is reached. Once the user enters all the required data for one speaker, he is asked if he wishes to accept that speaker. When all speakers are entered and accepted, the program INTKEY prints out a table showing the choices the user had made. An example of the output listing from executing INTKEY is shown in Figure 3.1. The source code for INTKEY is available from RADC/EEV.

```
INTERRUPTED WORD KEY FILE 4024.KEY
TOTAL % MISSING WORDS     13.5057
SPEAKER NO.   1 % MISSING WORDS    13.3621
                1234567890123456789012345678901234567890123456789012345678
                0000111000000011100001110000000000011100000000001110000000
                0011100000000000000001110000000010010000000000000000000000
                0000000000000000000000000000000000000000000111110000000000
                0000000000010110000000000000000000000000000000000000000000
                1234567890123456789012345678901234567890123456789012345678
SPEAKER NO.   2 % MISSING WORDS    12.5000
                1234567890123456789012345678901234567890123456789012345678
                0111000000000001110000111000000000000000000001110000000000
                0000000000111100000000000000000000000000000000000000000000
                0000000000000000000011110000000000001110000000000000000000
                0000000000000000000000111000000011100000000000000000000000
                1234567890123456789012345678901234567890123456789012345678
SPEAKER NO.   3 % MISSING WORDS    14.6552
                1234567890123456789012345678901234567890123456789012345678
                0111000000000001110000000000000000011100000000000000000000
                0000000000000000000000111000000000000000000011100000000000
                0000000000000000000000000000000000000000000000111111000000
                0001111000000000001111000000000000011111000000000000000000
                1234567890123456789012345678901234567890123456789012345678
```

Figure 3.1
Example of INTKEY program output

CHAPTER 4

DIAGNOSTIC RHYME TEST COMPARATIVE ANALYSIS SYSTEM

Comparative analysis of DRT results is available through a software package called MENU. With this package, an analyst is able to access all DRT systems that are stored on Data Base volumes. This is a menu-driven program which provides the capability to select various options as shown in the main menu listed below.

1 = DRT PRINTOUT OF COMPLETE RESULTS
2 = DRT SUMMARY PRINTOUT
3 = PLOT DRT PROFILE
4 = ANALYSIS OF VARIANCE 2 TO 9 SYSTEMS
5 = STUDENTS'S T-TEST FOR 2 SYSTEMS
6 = PROBE ANALYSIS
7 = LIST DATA BASE
8 = LIST RAW DATA
9 = ENTER AND PLOT *** DAM *** DATA
10= CULL LISTENERS
11= AVERAGE ACROSS SYSTEMS 2 TO 9 SYSTEMS
12= MERIT LISTENERS
0 = EXIT MENU

Most of the twelve programs have been described in previous reports (Ref. 7). New options and modifications to existing options will be described in this chapter. A maximum of two DRT Data Bases each with up to 100 systems can be accessed by MENU. Each DB is defined by its three files (DB.INX, DB.HDR, DB.DAT) and must be mounted on pseudo device DK2: or DK3:. Details of the DB file structure are given in Chapter 2 of this report. Output files from the various options are identified by the .DMP extension and are normally spooled to the printer and deleted. Options 3, 6, and 9 produce data plots and require the TEKTRONIX 4015-1 terminal located at the Speech Laboratory. The source code for this latest version of the MENU package is available from RADC/EEV.

4.1 GLOBAL MODIFICATIONS

A number of revisions were made to the MENU package.The revisions were motivated by the need to remove existing "bugs" and the desire to add new capabilities to the package. Some of the changes extend to all of the tasks making up the MENU package while other changes are task specific.

The MENU package previously consisted of one overlayed task with separate analysis options implemented as subroutines. Due to the growth of the MENU package and potential future additions, it was not cost-effective to maintain the menu implementation as a single overlayed task. It has since been broken into a single executive task ... MENU ... which spawns the subtasks to perform one of the specific menu options. Thus each subtask can use a full 16-bit virtual address space.

The development of the new MENU package was performed on the DRTDEV virtual disk at [200,222] with the final executable files placed on [200,200]. An object library file, [200,222]MENULIB, was created to contain all object modules required to build the MENU tasks. All of the tasks are altered to do some of the things previously done in the root section of the MENU task such as assigning LUN's to a listing file or to the graphics terminal, calling SYSSEL to select systems for analysis, and controlling program flow.

The MENU package was also revised to permit the analysis of "interrupted" DRT data. Comparisons between interrupted and non-interrupted systems is possible as all data is ultimately represented by a percentage correct score. The revision called for a larger data structure to contain the percentage scores. The GETSXL subroutine was changed to detect interrupted systems and to create percent correct scores on the basis of test items presented. The STATS subroutine was changed so as not to convert statistics to percentage scores, but instead expects the data passed to it to already be in a percentage format. In all output listings generated by MENU, interrupted systems are now indicated by the presence of '/I' appended to the system's identification number.

Another modification to the MENU package was the introduction of speaker subsets. The first five options, PRINT, SUMARY, PLOT, ANOVA, and TTEST, allow the user to choose if they would like speaker subsets. What is meant by speaker subsets is that in systems with six speakers, the user can choose to use the first or last three speakers or all speakers when executing any of the first five options. When working with three speaker systems and the user chooses to do speaker subsets, the routine will print a message to the user and default to the first three speakers. In order to be able to handle this new option, a new subroutine called SYSTEM replaced the old subroutine SYSSEL because SYSTEM not only handles the entry of the system numbers and versions but also handles the input of what speakers to include in the analysis option chosen.

In response to any prompt in the MENU package, the user may enter a control Z which will then go through a sequence of steps before terminating the current task. A control Z sequence will close all files opened for output and stop once this is done where as before a control Z entered in response to a prompt would terminate and sometimes lock files used to execute the program. This modification of a control Z sequence affected mostly all routines in the MENU package and this sequence should be followed in every new addition to the analysis package.

Interrupted DRT systems are now recognized in the output listings of the MENU package. All system identification numbers for interrupted systems are postfixed with "/I" when displayed in any of the various subroutine outputs of MENU. All options, except XDAM, were affected by this modification.

When being prompted for the "number of listeners" in the subroutine QUERY and the user has selected the option to enter a specific number of listeners but has selected a number which is out of range, an error message is displayed and the user is given another chance to enter the number of listeners.

4.2 OPTION MODIFICATIONS

The PRINT option was changed to output its listings of processed data in a different order. The request for a complete printout will result in a multi-page report structured as follows:

1. a page for each listener giving mean scores and standard errors across speakers for all attributes.
2. a page for each speaker giving mean scores and standard errors across listeners for all attributes.
3. a page giving mean scores and standard errors across listeners and speakers for all attributes.
4. a matrix of listener-speaker scores.
5. a matrix of listener attribute scores.

The request for an abbreviated version will produce items 2, 3, 4, and 5 above.

The PROBE option in MENU was revised to accept the new GENERIC PROBE Data Bases with systems in the 9600-9899 range and to change the graphic display labels accordingly for these special data bases. With this addition, the routine can be used to provide functional plots of intelligibility vs experimental parameter. PROBE provides plots of DRT probe scores versus probe repetitions which are useful in tracking listener performance. These plots are also used for soundroom equipment evaluation so that problems with equipment can be found and corrected. There are several plot options within PROBE that allow the user to interactively select the data that best demonstrates what he is looking for. Since a Probe DB can contain up to 300 Systems, a movable window with a maximum size of 100 can be positioned within the

Probe DB. Several modifications were made to PROBE concerning the display of output. One such change was the scaling and centering of the output for maximum resolution when less than 20 systems are being displayed. Other changes involved checking for missing speakers and cleaning up the display's header format.

Other plot options in PROBE are: the selection of a specific speaker or the sum over all speakers; the selection of a specific listener, an average of the standard set of 8 listeners, or an average of all listeners; the selection of a specific attribute or the sum over all attributes; the selection of the present (p), absent (a), or combined (c) state of the attribute chosen; the selection of a composite plot with p/a/c states all plotted; and a linear regression fit to the listener, attribute, and state data chosen.

The p/a/c plots for a specific listener include the group performance (less the specified listener) with the 95% confidence intervals, the listener performance, and information on the listener attendance and performance relative to the group. The linear regression plots show the listener performance, a linear fit to that data, and a listing of the regression coefficients.

The TTEST option was also revised to test the significance of T-values made at alpha = .01 as well as at alpha = .05 depending on what the user specifies. If significant mean differences exist TTEST marks "*"'s next to the scores. The format of the output listing for TTEST was changed to allow for the display of these significant mean differences in all the tables. Also tests between two systems for only one user specified speaker or speaker subsets is now possible.

The XDAM option was modified to handle the plotting of new descriptors due to a change in the information contained in DAM test results received from Dynastat. Scaling of the XDAM plot was needed in order to include these new descriptors and larger arrays were made to handle the storage of the input of these values. A new subroutine, CHECK, was added to XDAM in order to allow the user to review and change any of the data he entered which might happen to be incorrect.

The RAWDAT option was revised to display test item counts along with the raw data of the system number requested when an interrupted DRT system is encountered. Lastly, the DBLIST option now generates automatic paging of its listings.

4.3 NEW OPTIONS

4.3.1 Analysis Of Variance Algorithm

A revised Analysis of Variance model was researched and implemented for use in the statistical analysis package of DRT test data. The experimental design previously established for the DRT MENU package was used as a guide for the development of the new ANOVA model. This multi-dimensional model provides a means for the testing of significant System, Speaker, and Feature effects on DRT scores, as well as significant "interaction" effects. The new model also takes into consideration the fact that the Speaker, and the Feature factors are "Repeated factors" meaning that each subject for a particular system is presented with DRT stimuli for each and every possible combination of speaker and feature included in the experiment. The System factor, however, is not considered a repeated factor since the experimental procedure does not demand that the same group of subjects be presented with the stimuli from all of the possible systems present in the study. The advantage of the repeated measure design lies within the fact that since each subject responds to stimuli representing all levels of a particular factor (e.g. Feature), there is no confounding of the source of response variation between the 'treatment' factor (e.g., Feature) and 'Between-subject' differences in response tendencies. The speech stimuli can be categorized on three important dimensions:

Feature--phonetic attributes of the stimuli
Speaker--who spoke it
System --what type of communication system processed the stimuli before its presentation to the subjects

The variability in the ability of the subjects to identify these stimuli as reflected in the DRT intelligibility scores can be assumed to be attributable to these three factors--Feature, Speaker, and System. The ANOVA technique provides a means of testing hypotheses concerning the variability seen in these scores (e.g., the hypothesis that the variation in DRT scores between systems is no different than the variation of scores seen for stimuli all processed by the same system).

The ANOVA model construct can be represented

$$(B \times C \times S/A) \times A$$

where A = System factor
B = Speaker factor
C = Feature factor
S/A = Subjects nested within System factor.

Note also that the term in parentheses indicates that the included factors are repeated measures. A table of the sources of response variations, their degrees of freedom, the computational formula used to determine their Sums of Squares (SS) values used in estimating mean variances, and the error terms used in hypothesis testing concerning these sources are provided in Table 4.1.

Source	df	SS computation	Error Term
******	**	**************	**********
System (A)	a-1	[A] - [T]	S/A
Speaker (B)	b-1	[B] - [T]	B x S/A
Feature (C)	c-1	[C] - [T]	C x S/A
Sys x Spk	(a-1)(b-1)	[AB]-[A]-[B]+[T]	B x S/A
Sys x Feat	(a-1)(c-1)	[AC]-[A]-[C]+[T]	C x S/A
Spk x Feat	(b-a)(c-1)	[BC]-[B]-[C]+[T]	B x C x S/A
Sys x Spk x Feat	(a-1)(b-1)(c-1)	[ABC]-[AB]-[AC]-[BC]+ [A]+[B]+[C]-[T]	B x C x S/A
Subjects/Sys	a(n-1)	[AS] - [A]	
Spk x Subj/Sys	a[(n-1)(b-1)]	[ABS]-[AS]-[AB]+[A]	
Feat x Subj/Sys	a[(n-1)(c-1)]	[ACS]-[AS]-[AC]+[A]	
Feat x Spk x Subj/Sys	a[(n-1)(b-1)(c-1)]	[ABCS]-[ABS]-[ACS]-[ABC]+ [AB]+[AS]+[AC]-[A]	

a = number of Systems
b = number of Speakers
c = number of Features
n = number of Subjects per System

****

Definition of terms in SS computation formulas are explained in Geoffery Koppel's Design and Analysis (Ref. 8 pp. 191-195).

Table 4.1

The significance of all main effects and interaction effects is determined by comparing the obtained F-ratio with a critical F value which represents a lower bound of expected F-ratios based upon the assumption that the actual population means under analysis are equal (i.e., the null hypothesis is true) and the probability of obtaining an F-value equal to or larger than this critical F value is at a known level. This probability level is referred to as the <u>alpha</u> level and represents the level of 'risk' that the researcher is willing to take in falsely rejecting the null hypothesis and concluding that there are significant mean differences when in fact the population means are equal. The critical F value for a given alpha level and degrees of freedom parameters can be obtained from the appropriate sampling distribution of the F statistic and is readily available via statistical tables.

The F-ratio formed by the estimator of the variability of scores between systems (i.e., mean squares for System factor) and the estimator of the variability of scores within systems (i.e., mean squares for 'subjects nested in systems', Subj/Sys) can be used to test the hypothesis that the mean difference between systems is zero. That is, this statistic can be used to determine whether the systems differ statistically in their overall intelligibility scores. Upon the detection of significant System differences, a more detailed analysis to pinpoint which particular system differs from others is made using the "pairwise mean comparison" technique known as the Newman-Kuels.

The pairwise comparison analysis is called only if the System main effect is significant. The formula used to determine the critical mean difference (C.D.) between a pair of means is:

C.D. = q (r,df) * sqrt(MSerr / b*c*n)

where q = Studentized Range Statistic determined by the parameters r, df, and the alpha level chosen
r = the number of 'steps' between the pair of means being compared
df = the degrees of freedom of the System Factor's error term (i.e., Subj/Sys)
MSerr = the Mean Square of the System Factor's error term
b = the number of speakers
c = the number of features
n = the number of subjects per system

Note that the critical mean difference used to compare a pair of means will depend on the number of means located between the pair. The Studentized Range Statistic required for a particular comparison is evaluated at a specific alpha level and is realily available via statistical tables.

The System by Feature interaction term is used to determine if a pattern of Feature scores is consistent across all individual systems included in the study. If the System by Feature interaction term is significant, the evaluation of the simple main effects of the System factor at each level of the Feature factor is carried out. That is, the differences across all systems for each of the particular speech attributes is tested for significance in an attempt to clarify how the Feature scores differ from system to system. A separate error term is calculated for each simple main effect which uses only the scores involved at the Feature level for which the effect is being evaluated. For a discussion of the rational for using the separate error terms for each simple main effect as compared to a more 'heterogeneous' approach to the selection of error terms as prescribed by Winer (Ref. 9) see Koppel's Design and Analysis (Ref. 8 pg. 442).

The numerator term for the F-ratio used to evaluate this simple main effect at a given Feature level is derived using the following formula to determine the sums of squares:

$$SS_{A\ at\ C_k} = \frac{\sum_{i=1}^{a} (\sum_{m=1}^{n} \sum_{j=1}^{b} d)^2}{nb} - \frac{(\sum_{i=1}^{a} \sum_{m=1}^{n} \sum_{j=1}^{b} d)^2}{anb}$$

with degrees of freedom = a - 1.

where i = index over Systems
j = index over Speakers
k = index over Features
m = index over Subjects (Listeners) per System
d = experimental data point at i,j,k,m

The F-ratio denominator term is

$$SS_{S/A\ at\ C_k} = \frac{\sum_{i=1}^{a} \sum_{m=1}^{n} (\sum_{j=1}^{b} d)^2}{b} - \frac{\sum_{i=1}^{a} (\sum_{m=1}^{n} \sum_{j=1}^{b} d)^2}{nb}$$

with a * (n-1) degrees of freedom.

The System by Speaker interaction term is used to determine if a pattern of Speaker scores is consistent across all individual systems included in the study. If the System by Speaker interaction term is significant the evaluation of the simple main effects of the System factor at each level of the Speaker factor is carried out. That is, the differences across all systems for each of the particular speakers is tested for significance in an attempt to clarify how the Speaker scores differ from system to system.

The F-ratio used to evaluate this simple main effect for a given Speaker is derived in the same manner as used for the Feature effect across Systems. For the Speaker effect all occurences of the indicies "j" and "k" are swapped in the preceding equations.

<u>ANOVA</u> <u>Software</u> <u>Implementation</u> - The program ANOVA has been developed to perform the required computations for the new Analysis of Variance of DRT systems in the comparative analysis DB. It replaces the previous ANOV routine and can be found on the virtual disk DRTDEV at UIC [200,200]. The user specified inputs required for this software module include the number of systems to compare, the particular systems in the data base to compare, the number of subjects to be included, the speakers or speaker subset to be included and the alpha level at which to mark significant differences. Previously written subroutines that access the data base were retained. The output of this module consists of:

1. A vector of means for each Main effect (i.e., System, Speaker, Feature).
2. A matrix of means for each Interaction effect (e.g., Sys x Feat).
3. An Analysis of Variance Table listing for each source:
    1. the sum of the square deviations
    2. the degrees of freedom
    3. the mean square deviation
    4. the F ratio and indication of significance.
    5. the critical F ratio value from a lookup table
4. If the System main effect is significant, the results of a multiple pairwise comparison of the System means using the Newman-Kuels technique are displayed in the form of a matrix of mean differences for all possible pairs of systems included in the study. Also included is an indication as to whether each mean difference is statistically significant. This output is provided by the subroutine NKUELS.
5. If the System x Feature interaction is significant, an analysis of the simple main effect of Systems at each Feature level is performed. A test of significant system differences for each Feature level is made and a display of the Sums of Squares (SS), Mean Squares (MS), and the F ratio is provided for each simple main effect. Also displayed for each Feature level is an error term's Sums of Squares and Mean Squares values. This output is provided by the subroutine SMAINF.
6. If the Speaker x System interaction is significant, an analysis of the simple main effect of Systems at each Speaker level is performed. A test of significant system differences for each Speaker level is made and a display of the Sums of Squares (SS), Mean Squares (MS), and the F ratio is provided for each simple main effect. Also displayed for each Speaker level is an error term's Sums of Squares and Mean Squares values. This output is provided by the subroutine SMAINS.

The F-ratios obtained for the Main effects and the interaction effects are compared with a critical F-ratio obtained from the file "FDIS.TBL". This file is formatted to perform as a lookup table with indexing provided by the degrees of freedom for the numerator and denominator of the F-ratio. The Studentized Range Statistic required by NKUELS for a particular comparison is looked up in the file "QDIS.TBL". Both tables contain values for alpha levels of 0.05 and 0.01. These tables are located on DK1:[200,200] for use with MENU and on the virtual disk DRTDEV at UIC [200,200].

4.3.2 System Average Profile

A new option called AVGSYS was implemented into the DRT MENU package to enable the analyst to obtain results averaged over several systems. AVGSYS allows for averages over two to nine systems. In order to accomplish this, three guidelines must be followed. The number of speakers, the speaker ID's, and the number of listeners must be the same in each of the systems included in the analysis. Once the guidelines are followed, the routine proceeds to output a report of the averages. Along with these averages by speaker, the report displays the standard error across listener by speaker interactions averaged across systems, what systems were included in this analysis along with the header information, the list of speakers in each system, and the number of listeners.

4.3.3 Listener Merit Coefficient

The PROBE method of tracking listener performance does not take into account how many times a listener was culled out of the final set of eight listeners used to calculate final DRT scores. Existing software was revised to keep a record of how often individual listeners are culled from the scoring process and to take into account whether they are culled for being above or below the statistical thresholds that are set. This new routine is called MERIT and has been added to the DRT MENU analysis package. The program operates on a "window" of systems in a probe DB. This window is defined in the same manner as in the PROBE option.

The MERIT option outputs a table of calculations for the analyst to use to evaluate each listener's performance. The calculations are:

1. The number of times (a_L) each listener L was actually present for the specified number of systems.
2. The number of times each listener was in positions 1 through 12 during a "culling" procedure similar to the CULL routine in the MENU package.
3. The ratio of the number of times each listener was "culled" out to the total number of times that listener was present.
4. A listener merit factor, D(L), calculated over all systems within the analysis window for which listener L was present. The equation for D(L) is presented below.

For a given listener L,

$$D_L = \frac{1}{a_L} \sum_{i=1}^{a_L} \frac{P_{iL}}{b_i n_i} \sum_{j=1}^{b_i} \delta_{ijL}$$

where

δ_{ijL} = deviation from speaker j's mean for system i at the level which listener L is culled from the listener crew

P_{iL} = level (12,11, ... ,1) at which listener L is culled from the listener crew for system i

a_L = total number of systems listener L participated in

b_i = number of speakers in system i

n_i = number of listeners in system i

By reviewing all of these calculations in the final output, the analyst can see which listener is being culled out most of the time in relation to the number of times that particular listener was present and also look at their normalized deviation to check whether they were always above or below the mean. These calculations are displayed in a table format where the analyst can observe them for each listener. The output is ordered in three different ways: by number of times present, by listener identification numbers, and by the culling out percentage. The user can also observe where a listener's position tends to be after the culling procedure takes place.

MERIT Software Implementaion - The program MERIT was developed to provide a better means of rating listener performance. MERIT requires either an EXPANDED or GENERIC PROBE DB at the pseudo device DK2 or DK3. If no PROBE disk was found on either, it prints a message and returns to the main menu in EXMAIN. If a PROBE disk is present, the routine displays the top PROBE system and how many systems exist on the disk. The analyst is then asked where to start the analysis and how many systems (referred to in the program as "window size") to be included in this analysis. The analyst may request from 3 to 300 systems but if the analyst does not enter a valid response the routine will default to the largest number of systems available. Note, however, the analyst must enter the top probe system number to be included because the routine begins the processing at the top system number and decrements each time until it reaches the "window size" specified.

This routine permits the user to get a full or abbreviated report of the processing. The full report consists of a listing of the listener ID's, the order of the listeners after the elimination procedure, the last variance at which each listener was eliminated, and their normalized deviation for each system included in the analysis. The final phase of this routine outputs three tables that contain the same information yet ordered in three different ways. All three tables display the computations described in the previous section. The first table orders them by the number of times each listener was present. The second table orders them by listener identification numbers and the third table is ordered by the culled out percentage. The abbreviated report only generates the three tables. Lastly, the analyst is requested to either choose a new window size or exit the program. If a new window size is chosen, the process starts all over again.

CHAPTER 5

DRT SYSTEM UTILITY PROGRAMS

This Chapter will describe three utility programs that are used with the RADC/EEV DRT System. The first of these routines, ZTILTY, provides for the maintenance of the Raw DRT Data Base while the second, DBTILTY, maintains the DRT Analysis Data Base. The third program, GENDB, is a new addition to the DRT System. This routine can be used to search the Analysis DB for systems with common characteristics. GENDB provides a list of the systems that may be edited by the EDT program and will generate a "generic probe data base disk" that contains the selected systems in sequential order. This disk can be used with any of the MENU options. Specifically, the PROBE and MERIT options will provide special information not previously available.

5.1 DRT RAW DB UTILITY

The main utility package used with the DRT Raw Data Base created at the USAF RADC/EEV Speech Processing Facility is ZTILTY. This package is a useful tool in the generation and maintenance of the already existing .ZFY files by providing certain options for the modification of raw data or header information that was incorrectly input. It also allows for the comparison of data from two files and dumps these differences to the user-specified device. ZTILTY also permits the generation of a new 3-speaker system from a subset of any three speakers of a 6-speaker system and the generation of two 3-speaker systems from a 6-speaker. Those two options have been used extensively in the past for analysis purposes. Other options included in ZTILTY concern the deleting of listener's data from a .ZFY file or the listing of file headers.

The program resides within the DRT/STAFF account on device DK1: and can be executed by the RUN ZTILTY command. The initial menu of options is:

1= FILE HEADER LISTINGS
2= FILE DUMP
3= FILE COMPARE AND DUMP
4= FILE HEADER AND MODIFY
5= LISTENER DELETE
6= DATA MODIFY
7= FILE MERGE
8= VOLUME HEADER LISTINGS
9= THREE SPEAKER SUBSET SYSTEM
0= END ZTILTY

Several input/output files are used by ZTILTY and are all expected to be found or created on the default local system device SY: at the default UIC (i.e., [200,200]). A description of the files used by the options is as follows:

```
ZFILE  = (NNNN.ZFY;VV) MAIN INPUT .ZFY FILE
XFILE  = (MMMM.ZFY;VV) SECONDARY INPUT .ZFY FILE
MFILE  = (NNNN.MOD;VV) MODIFIED OUTPUT .ZFY FILE
SPFILE = (NNNN.DMP;VV) SPOOLED OUTPUT LISTING FILE
```

where NNNN and MMMM are DRT system numbers; .ZFY and .MOD files are DRT output listing files; and .DMP file is an ASCII output file.

This program has not been modified during this contract period. A full description of the program can be found in Reference 7.

5.2 DRT ANALYSIS DB UTILITY

An Analysis Data Base utility program is available through the routine DBTILTY. This utility program is mainly used for data base maintenance. It resides within the DRT/STAFF account on device DK1: and can be executed by the RUN DBTILTY command. The initial menu of options is:

1 = DB SIZE AND SERIES
2 = DB DIRECTORY
3 = DB SYSTEM DELETE
4 = LIST (MODIFY) A SYSTEM HEADER
5 = INITIALIZE A DB DISK
6 = MODIFY A SERIES OF SYSTEM HEADERS
7 = POINT TO A DATA BASE
0 = EXIT DBTILTY

The ability to modify a data base due to problems such as misspellings of titles or improper speaker ID's that have slipped past the DRT scoring program is possible in DBTILTY. Yet, the package does not provide any means of modifying the data itself. This feature was purposely not provided. It is our philosophy that problems with the data should only be addressed at the .ZFY level. Using ZTILTY allows booklet and page modification but does not affect the scoring of a system. Therefore the data only can be directly modified and not the scores. Bad data resulting from wrong wordlists or booklet order can be deleted using DBTILTY followed by the correcting of the original error in the corresponding NNNN.ZFY file with ZTILTY and the rescoring of that system with DRT.

Most of the options have been described in previous reports (Ref. 7). New options and modifications to the existing options are presented in the next section. The source code for this latest version of DBTILTY is available from RADC/EEV.

DBTILTY can access either of two Analysis DB files that have been mounted on pseudo device DK2: or DK3:. No other input files are used with the exception of OPTION 6 which will be discussed in a later section. The only output file, DBLIST.DMP, is created by OPTION 2 of DBTILTY when the analyst chooses to output the DB volume directory to the line printer (LP).

It is important to note two facts. First, this package can effect important data files and should only be used by personnel that fully understand the data and file structures involved. Secondly, before any change is made to the data base disk the program will execute a PAUSE to give the user a final chance to exit or abort if he is not sure of the change.

5.2.1 Option Modifications

The DELETE option was modified to handle the deleting of files more efficiently. The previous delete option would find the system's location in the INDEX or IOVFLO arrays and replace that system number with zeroes thus causing what has been labeled "holes" in the Data Base. "Holes" in the IOVFLO array have been found to create a problem when adding new versions of systems that already exist. If a "hole" existed in IOVFLO, the newer version would be added before the older version and therefore creating an out of sequence version. For example, if the user requested a listing of that Data Base, the newer version just added would appear before the older version and the dates will not be oldest to newest as they should be for analysis purposes.

To eliminate "holes", the DELETE routine moves the data stored in the next location into the location of the deleted system and repeats this similar process until all the data is moved up therefore fixing the problem of a hole in the data base. The revised DELETE option will also work on expanded probe disks in a similar manner. The differences are that the system numbers change when data is being moved up since they are not significant to the system and the INDEX array as well as the IOVFLO array is moved up to eliminate holes.

The previous delete option only allowed the user to delete either a specific version greater than 1 or all versions of a particular system number. The revised DELETE allows the user to delete any system and version requested. The user has the choice of deleting all versions of a particular system when he enters the system number and version 1 where as before there was no choice, it would automatically delete all versions even if the user just wanted to delete only version 1.

THE DBLIST option was revised to handle the listing of interrupted systems. The user can look at the system number in the listing of the data base directory and see what systems were interrupted.

5.2.2 New Options

A new service option was implemented into the DBTILTY program to enable a user to point to either psuedo device DK2: or DK3:. Previously, the assignment had to be made each time an option was selected. To alleviate this inconvenience the POINT TO A DATA BASE option was added. This option provides an easier method of obtaining the desired Data Base simply by entering the DK number where the DB resides. Then, the routine assigns the appropriate logical unit numbers to the three files of the Data Base. If a data base is not found at the DK number entered, error messages appear and the routine pauses to allow the user to assign a data base. The user must enter a RESUME to continue executing DBTILTY once the assignment has taken place. If a data base is present, the routine brings up the main menu once again and execution on that new data base is possible.

Option #6 was implemented into DBTILTY to handle modifying a series of system headers rather than doing each one individually with option #4. The new option uses the edited output file LIST.DAT created from the execution of the GENDB program. The file LIST.DAT must be renamed DBHEAD.TTL before executing this option.

Option #6 allows the user to do the following: view the DBHEAD.TTL file to see what system numbers and versions are contained in this file; modify all versions of the system header that exist for each system number in DBHEAD.TTL without user intervention; modify each system header separately with user intervention (i.e., being asked to modify this system) every time a new system is found; or, modify specific system numbers and versions which are all contained in DBHEAD.TTL. Due to the implementation of the modify a series of headers option, the problem of inconsistent system headers within versions of the same system can be resolved.

5.3 GENERIC PROBE DRT DATA BASE GENERATION PROGRAM

A program was developed to fill a GENERIC PROBE DRT Data Base (GPRB) with selected systems from existing Data Bases. The program is called GENDB and can be found on the DRTDEV virtual disk at [200,211]. The program uses Data Bases assigned to logicals DK2: and DK3: as sources of system data to fill the Data Base assigned the logical DB:. The output Data Base, namely GPRB, must be initialized to contain system numbers 9600 to 9899 in an 'extended Probe' format. The 9600 series indicates that this is a generic probe DB.

The selection of the systems from the source Data Bases can be done in one of three ways:

1. Systems to be selected are specified in order within a text file LIST.DAT which can be generated with EDT or by previous runs of GENDB. Each record of LIST.DAT contains a system number, a version number, and the title field from the header record for the system. (Note: if generating LIST.DAT with EDT, only the system and version numbers are required.)
2. Systems to be selected are specified interactively with the user typing in system and version number during the execution of GENDB.
3. Selection of systems based upon specified contents of the title field within its header record. The title field can be used in evaluating expressions consisting of substrings and the boolean operators OR, AND, and NOT. If the resulting expression evaluation returns a true value, the system is selected for inclusion in the output Data Base. An order of the evaluation of systems is also possible by using constructs such as ['xxxx'.OR.'yyyy'] where a search for the 'xxxx' substring is carried out first and then a second search is made for the other substring. More than one of these structures can be given within a search expression for multiple layers of ordering. The option to require the presence of specified speakers in the system is also available.

Once systems have been selected and the LIST.DAT file is generated, the user has the option of reviewing and revising this list by using the EDT utility which is spawned by GENDB on command. The edited LIST.DAT is used during the data transfer process in which system data is copied into the GPRB Data Base. Previous data in GPRB is overwritten when GENDB is executed.

The source code for GENDB is available from RADC/EEV.

CHAPTER 6

DRT TESTING OF INTERRUPTED VOICE COMMUNICATION SYSTEMS

New capabilities have been developed at the RADC/EEV Speech Processing Facility for simulating noisy, delayed digital communication channels and for obtaining Diagnostic Rhyme Test (DRT) scores for communication systems operating over the simulated channel. Intelligibility scores for processed speech transmitted over the channel can be obtained by using a DRT test procedure which generates scores (i.e., percentage of words correctly recognized) on the basis of only test items successfully transmitted while items "interrupted" by error bursts are disregarded during the DRT scoring process.

Testing of "interrupted systems" with the modified DRT does not provide a complete measure of the intelligibility of the system by itself. This score must be combined with a measure of the percent of transmission time that the communications channel has zero intelligibility (i.e. the channel is effectively shut down). The Channel Down Time (CDT) measure plus the modified DRT score gives a complete picture of the system's intelligibility. CDT measures will be discussed in this Chapter.

The software modifications to the RADC/EEV DRT System for the incorporation of interrupted speech communications intelligibility testing have been covered in Chapters 2 - 5 of this report. A procedure for the selection of which test words are missing from a DRT tape is discussed in Chapter 3 of this report. This Chapter will give the background in the development of the test method, a justification for the method and results that validate the approach.

6.1 A STUDY OF THE DRT AS A MEASURE OF INTELLIGIBILITY WITH INTERRUPTED VOICE COMMUNICATION SYSTEMS

Intelligibility testing of some voice communication systems can include the situation where silence or garbled noise replaces the speech signal at the receiver for periods of time from 1 to 10 seconds. Often a squelch algorithm has been used to insert silence when high transmission errors are detected. Such systems will be referred to as "interrupted systems" in this report.

The standard tool for the measurement of intelligibility of voice communication systems is the Diagnostic Rhyme Test (DRT). In the DRT individual words from rhyming pairs are presented by audio tape to a listener crew at a pace of approximately 1.3 seconds. At RADC/EEV a listener responds to each word presented by striking a key on a data entry unit (DEU) to indicate which word the listener believes he/she heard. This response scrolls a word-pair display on the screen of the DEU. The response keeps the word-pair display in synchronization with the audio tape word presentation. If a listener does not respond to a word choice, the DEU display will fall behind the audio tape and the listener can lose place in the test.

For interrupted systems the location of silent or garbled periods tends to be scattered randomly within a DRT tape. This results in "missing words" within the word list. Since these missing words are on the audio tape, they will require all members of the listener crew to guess at what word should have been presented. A guessing correction algorithm is used in the scoring procedure for the DRT. This algorithm weights wrong answers by 2 and correct answers by 1. A 50/50 chance test with all guesses will result in a score of 0.0, a clear system with all correct answers will score 100.0, and a system that has all wrong answers will score a -100.0.

Testing of "interrupted systems" with the DRT at RADC/EEV does not provide a complete or accurate measure of the intelligibility of the system. Since the missing words are scattered throughout the wordlists, the diagnostic attribute or feature scores provided by the DRT become inaccurate. An adjusted score can be provided if the specific missing words are known for a given word list. An adjusted DRT report coupled with a measure of the percent time the transmission was affected by squelch or garble will provide a complete measure of the system's intelligibility.

The most important aspect of an interrupted DRT is still not addressed by the missing word correction. Do missing word sequences effect future word choices because of synchronization loss by the listener crew? Do the listeners lose their place between the audio tape and DEU word display and if so, how long does it take a trained listener to catch up? This type of error will be referred to as Follow Through or Projected Error. A controlled experiment has been conducted to answer these questions.

6.1.1 Experimental Design

A 3-Speaker DRT wordlist (JE,CH,RH 3Male Quiet/Dynamic Mic) available on the EEV Speech Data Base (DB) was modified with the ILS package. Words were removed from the list and replaced with silence, acoustic noise or transmission noise. All testing was done with 96kbps PCM speech as output from the Speech DB by MAPOUT. Up to five consecutive words were replaced, resulting in interruptions of from 1 to 6.5 seconds. The DRT wordlists are structured with sets of six test words, for the six attributes being evaluated, separated by spacer or experimental words. Since the DRT was originally setup to be performed with paper booklets, there are also spacer words at the tops and bottoms of columns of word choices. There are four pages within a DRT booklet and extra time is given within the audio tapes for page turns. This structure allows for the removal of up to two consecutive words and the introduction of several seconds of noise without effecting the intelligibility measurement of a system.

Two sets of tests (A & B) were generated from the Speech DB file of DRT tape D-2-A. Each set has three test tapes, one each for words replaced with silence, acoustic noise, and transmission noise. EC-130 aircraft acoustic background noise was used to replace the words in the acoustic noise version of the test. A simulated transmission channel noise, taken from DRT tapes with actual burst error conditions, was used to replace the words in the transmission channel noise version of the test.

Set A has 33 replaced words in total with 11 of these being test words. Set B is an extension of Set A with a total of 45 replaced words with 23 of these being test words. The effects on DRT results from test words that are removed can be calculated for the case where no listener synchronization loss has taken place. Tables 6.1 & 6.2 give details on the numbers and types of words removed along with the predicted effects for the DRT results as given after the "/". The specific words removed and the sequences of words involved are given in the Figure 6.1 in the form of a DRT Booklet.

Table 6.1 SET A

Replaced Word Attributes and Predicted DRT Effects

System 2669 Silence Replaces Words
System 2670 Acoustic Noise Replaces Words
System 2671 Transmission Burst Error Noise Replaces Words

	# Words	#Spacer Words	#Test Words	# V	# N	# Su	# Si	# G	# C
Spkr JE	11	9	2/1.0	-	-	-	-	-	2/6.2
Spkr CH	11	7	4/2.1	4/12.5	-	-	-	-	-
Spkr RH	11	6	5/2.6	2/6.2	-	-	-	-	3/9.4
Total	33	22	11/1.9	6/6.2	-	-	-	-	5/5.2

Table 6.2 SET B

Replaced Word Attributes and Predicted DRT Effects

System 2672 Silence Replaces Words
System 2673 Acoustic Noise Replaces Words
System 2674 Transmission Burst Error Noise Replaces Words

	# Words	#Spacer Words	#Test Words	# V	# N	# Su	# Si	# G	# C
Spkr JE	16	9	7/3.6	2/6.2	-	-	1/3.1	1/3.1	3/9.4
Spkr CH	16	7	9/4.7	5/15.6	1/3.1	1/3.1	-	1/3.1	1/3.1
Spkr RH	13	6	7/3.6	2/6.2	-	-	1/3.1	1/3.1	3/9.4
Total	45	22	23/3.9	9/9.4	1/1.0	1/1.0	2/2.1	3/3.1	7/7.3

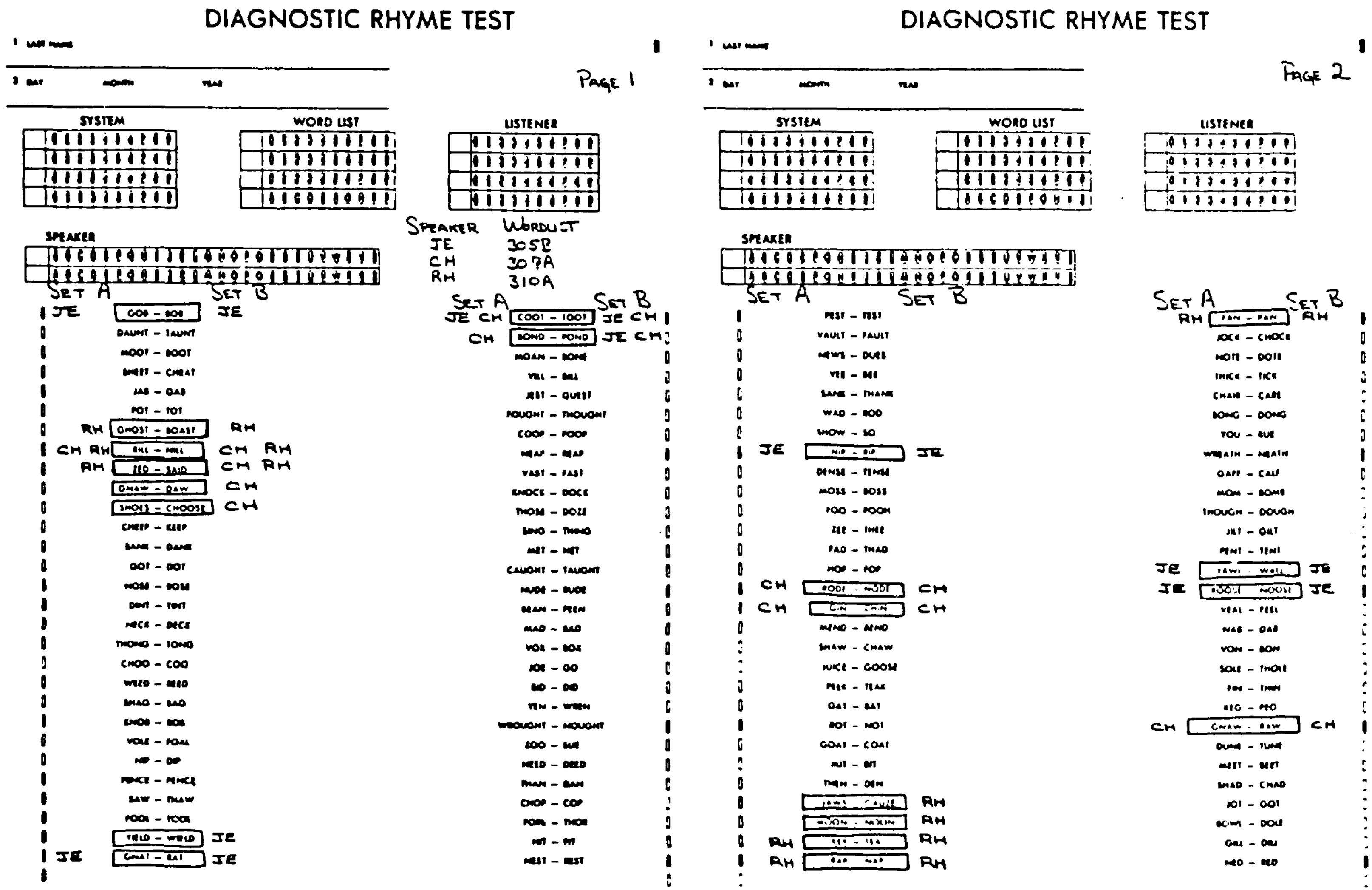

Figure 6.1 DRT Booklet (Pages 1 and 2)

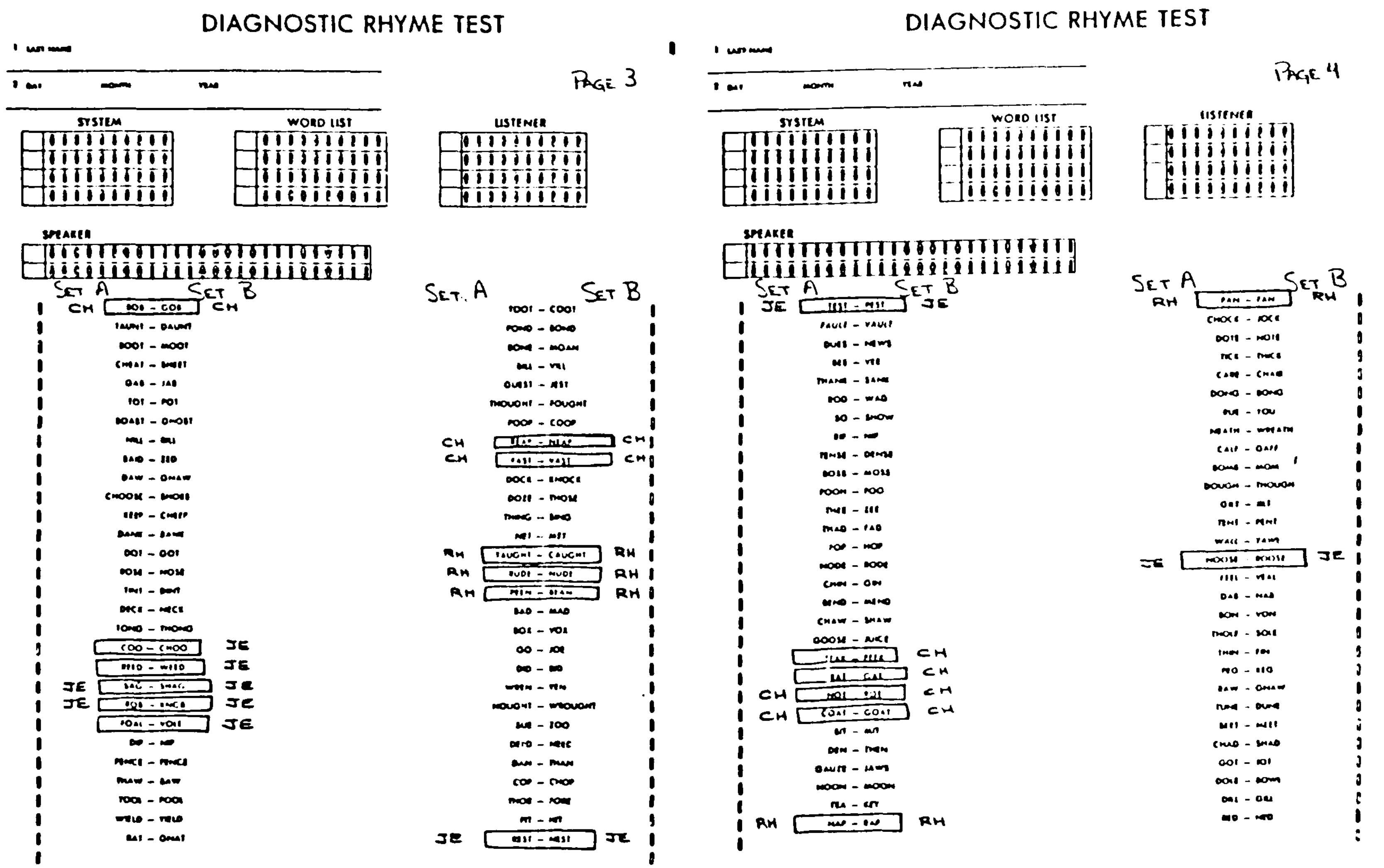

Figure 6.1 (Continued) (Pages 3 and 4)

6.1.2 Data Analysis

The modified wordlist tapes were evaluated by the EEV listener crew, with several repeats carried out for each tape. Test results from a base line system evaluation (no missing words) are provided in Table 6.3. These results have been averaged over repeats of the system. Averaged test results for the systems with missing or replaced words are given in Tables 6.4 - 6.9. These tables also give the actual and predicted differences (delta = baseline - interrupted). The effect that we are trying to isolate is a Projected Error on words following a sequence of replaced or missing words. The tables indicate those attribute scores where this effect will be seen if it exists. The number of times (n) that an attribute word follows a number of replaced words (m) is indicated as n*Dm. There could also be a cascade effect that would be noticed in the score of the second attribute following a missing sequence. It should be noted that these are not full bandwidth analog systems, but bandlimited (100Hz HP / 4000Hz LP) 96kbps PCM systems. Also note that the standard errors (S.E.) given are across listener by speaker interactions as averaged across systems for all of these tables.

Table 6.3
SYSTEM 2656 PDP-11/44 D-2-A DISK MASTER 3M/Q/DYN

		FEATURES						
		V	N	SU	SI	G	C	TOTAL
SPEAKER NUMBER 1								
	P+A: MEAN	86.2	99.5	93.1	99.1	94.8	99.2	95.3
	S.E.	0.9	0.2	1.5	0.5	0.9	0.6	0.3
SPEAKER NUMBER 2								
	P+A: MEAN	98.8	99.5	98.8	98.8	91.2	98.9	97.7
	S.E.	0.4	0.3	0.5	0.7	1.2	0.6	0.2
SPEAKER NUMBER 3								
	P+A: MEAN	98.3	98.6	99.8	97.2	93.4	98.6	97.7
	S.E.	0.6	0.8	0.2	0.8	0.3	0.9	0.2
SPEAKER AVERAGE								
	P+A: MEAN	94.4	99.2	97.2	98.3	93.2	98.9	96.9
	S.E.	1.3	0.3	0.8	0.4	0.6	0.4	0.3

THIS REPORT IS THE AVERAGE OF THE FOLLOWING SYSTEMS
SYSTEM 2656 VER 1 - 5 (20-NOV-85;22-NOV-85;29-NOV-85;09-JUL-86;11-JUL-86)
THIS REPORT IS FOR 8 LISTENERS PER SYSTEM - SPEAKERS JE CH RH

Table 6.4 SET A

SYSTEM 2669 INTERRUPTED DRT ZEROED WORDS D2A 3M/Q/DYN

	FEATURES						
	V	N	SU	SI	G	C	TOTAL
SPEAKER NUMBER 1							
P+A: MEAN	86.1	99.0	93.5	98.8	94.7	92.3	94.0
S.E.	1.2	0.3	1.1	0.4	0.7	0.7	0.4
DELTA ACT/PRED	.2/0.	.6/0.	-.4/0.	.2/0.	.2/0.	6.9/6.2	1.3/1.0
	3*D2						
SPEAKER NUMBER 2							
P+A: MEAN	84.9	98.8	97.9	98.2	91.4	98.8	95.0
S.E.	0.8	0.2	0.7	0.6	1.5	0.4	0.2
DELTA ACT/PRED	13.8/12.5	.7/0.	.8/0.	.6/0.	-.2/0.	.1/0.	2.6/1.9
		4*D2					
SPEAKER NUMBER 3							
P+A: MEAN	93.4	97.1	99.1	96.4	94.7	90.9	95.2
S.E.	0.9	1.0	0.2	1.1	1.5	0.5	0.2
DELTA ACT/PRED	4.9/6.2	1.4/0.	.8/0.	.8/0.	-1.2/0.	7.7/9.4	2.4/2.6
	1*D2/1*D3	2*D3					
SPEAKER AVERAGE							
P+A: MEAN	88.1	98.3	96.8	97.8	93.6	94.0	94.8
S.E.	1.0	0.4	0.7	0.5	0.8	0.8	0.2
DELTA ACT/PRED	6.3/6.2	.9/0.	.4/0.	.5/0.	-.4/0.	4.9/5.2	2.1/1.9

THIS REPORT IS THE AVERAGE OF THE FOLLOWING SYSTEMS
SYSTEM 2669 VER 1 - 6 (25-JUN-86 A;25-JUN-86 B;26-JUN-86 A;26-JUN-86 B;
02-JUL-86 A;02-JUL-86 B)
THIS REPORT IS FOR 8 LISTENERS PER SYSTEM - SPEAKERS JE CH RH

Table 6.5 SET A

SYSTEM 2670 INTERRUPTED DRT EC-130 *NOISEWORDS D2A* 3M/Q/DYN

	FEATURES						
	V	N	SU	SI	G	C	TOTAL
SPEAKER NUMBER 1							
P+A: MEAN	86.7	99.1	95.2	99.4	95.6	93.1	94.8
S.E.	2.0	0.4	1.1	0.4	0.8	0.7	0.5
DELTA ACT/PRED	-.5/0.	.4/0.	-2.0/0.	-.3/0.	-.7/0.	6.1/6.2	.5/1.0
	3*D2						
SPEAKER NUMBER 2							
P+A: MEAN	85.7	98.8	98.2	97.7	91.9	99.2	95.2
S.E.	1.1	0.6	0.7	0.8	1.2	0.4	0.3
DELTA ACT/PRED	13.0/12.5	.7/0.	.6/0.	1.1/0.	-.7/0.	-.3/0.	2.4/1.9
		4*D2					
SPEAKER NUMBER 3							
P+A: MEAN	94.1	97.4	99.6	96.5	93.9	91.8	95.6
S.E.	1.0	0.6	0.2	1.0	0.5	1.0	0.4
DELTA ACT/PRED	4.1/6.2	1.2/0.	.2/0.	.7/0.	-.4/0.	6.8/9.4	2.1/2.6
	1*D2/1*D3	2*D3					
SPEAKER AVERAGE							
P+A: MEAN	88.8	98.4	97.7	97.8	93.8	94.7	95.2
S.E.	1.1	0.3	0.6	0.5	0.6	0.8	0.2
DELTA ACT/PRED	5.6/6.2	.8/0.	-.4/0.	5/0.	-.6/0.	4.2/5.2	1.7/1.9

THIS REPORT IS THE AVERAGE OF THE FOLLOWING SYSTEMS
SYSTEM 2670 VER 1 - 6 (25-JUN-86 A;25-JUN-86 B;26-JUN-86 A;26-JUN-86 B;
02-JUL-86 A;02-JUL-86 B)
THIS REPORT IS FOR 8 LISTENERS PER SYSTEM - SPEAKERS JE CH RH

Table 6.6 SET A
SYSTEM 2671 INTERRUPTED DRT BURST WORDS D2A 3M/Q/DYN

	FEATURES						
	V	N	SU	SI	G	C	TOTAL
SPEAKER NUMBER 1							
P+A: MEAN	87.2	98.7	95.0	99.1	95.3	92.8	94.7
S.E.	1.8	0.7	1.1	0.4	1.2	0.9	0.4
DELTA ACT/PRED	-1.0/0.	.8/0.	-1.9/0.	0./0.	-.5/0.	6.4/6.2	.6/1.0
	3*D2						
SPEAKER NUMBER 2							
P+A: MEAN	85.6	99.6	98.0	97.4	91.2	98.7	95.1
S.E.	1.0	0.2	0.6	0.5	1.0	0.6	0.3
DELTA ACT/PRED	13.2/12.5	-.1/0.	.7/0.	1.4/0.	.1/0.	.2/0.	2.6/1.9
		4*D2					
SPEAKER NUMBER 3							
P+A: MEAN	92.2	96.7	99.7	97.0	94.1	90.5	95.0
S.E.	1.3	0.9	0.2	1.1	1.4	0.5	0.3
DELTA ACT/PRED	6.1/6.2	1.8/0.	.1/0.	.2/0.	-.7/0.	8.1/9.4	2.6/2.6
	1*D2/1*D3	2*D3					
SPEAKER AVERAGE							
P+A: MEAN	88.3	98.4	97.6	97.8	93.5	94.0	94.9
S.E.	1.0	0.4	0.6	0.4	0.7	0.8	0.2
DELTA ACT/PRED	6.1/6.2	.9/0.	-.4/0.	.5/0.	-.4/0.	4.9/5.2	1.9/1.9

THIS REPORT IS THE AVERAGE OF THE FOLLOWING SYSTEMS
SYSTEM 2671 VER 1 - 6 (25-JUN-86 A;25-JUN-86 B;26-JUN-86 A;26-JUN-86 B;
02-JUL-86 A;02-JUL-86 B)
THIS REPORT IS FOR 8 LISTENERS PER SYSTEM - SPEAKERS JE CH RH

Table 6.7 SET B
SYSTEM 2672 INTERRUPTED DRT ZEROED WORDS D2A 3M/Q/DYN

	FEATURES						
	V	N	SU	SI	G	C	TOTAL
SPEAKER NUMBER 1							
P+A: MEAN	80.7	98.7	92.4	95.6	95.6	90.9	92.3
S.E.	1.9	0.6	1.5	1.1	0.6	1.0	0.4
DELTA ACT/PRED	5.5/6.2	.8/0.	.7/0.	3.5/3.1	-.7/3.1	8.3/9.4	3.0/3.6
	2*D2	1*D4/1*D5					
SPEAKER NUMBER 2							
P+A: MEAN	81.8	94.0	93.5	97.9	91.7	98.2	92.8
S.E.	1.2	1.1	0.6	0.7	1.7	0.5	0.3
DELTA ACT/PRED	17.0/15.6	5.5/3.1	5.3/3.1	.8/0.	-.4/3.1	.7/3.1	4.8/4.7
		3*D2/1*D4		1*D4			
SPEAKER NUMBER 3							
P+A: MEAN	93.2	98.2	99.2	94.5	90.1	92.2	94.6
S.E.	1.8	0.7	0.4	1.7	1.6	1.1	0.8
DELTA ACT/PRED	5.0/6.2	.4/0.	.6/0.	2.7/3.1	3.3/3.1	6.4/9.4	3.1/3.6
	1*D2/1*D5	2*D3					
SPEAKER AVERAGE							
P+A: MEAN	85.2	97.0	95.0	96.0	92.4	93.8	93.2
S.E.	1.5	0.6	0.8	0.7	0.9	0.8	0.4
DELTA ACT/PRED	9.2/9.4	2.3/1.0	2.2/1.0	2.3/2.1	.7/3.1	5.2/7.3	3.6/3.9

THIS REPORT IS THE AVERAGE OF THE FOLLOWING SYSTEMS
SYSTEM 2672 VER 1 - 3 (09-JUL-86;11-JUL-86 A;11-JUL-86 B)
THIS REPORT IS FOR 8 LISTENERS PER SYSTEM - SPEAKERS JE CH RH

Table 6.8 SET B

SYSTEM 2673 INTERRUPTED DRT EC-130 NOISEWORDS D2A 3M/Q/DYN

	FEATURES						
	V	N	SU	SI	G	C	TOTAL
SPEAKER NUMBER 1							
P+A: MEAN	81.5	97.9	94.3	95.8	93.0	90.9	92.2
S.E.	1.8	0.8	1.4	1.0	1.0	0.9	0.5
DELTA ACT/PRED	4.7/6.2	1.6/0.	-1.1/0.	3.2/3.1	1.9/3.1	8.3/9.4	3.1/3.6
	2*D2	1*D4/1*D5					
SPEAKER NUMBER 2							
P+A: MEAN	80.2	96.1	91.4	97.4	89.8	96.6	91.9
S.E.	2.0	0.9	1.3	0.6	1.6	0.7	0.4
DELTA ACT/PRED	18.5/15.6	3.4/3.1	7.3/3.1	1.4/0.	1.4/3.1	2.3/3.1	5.7/4.7
		3*D2/1*D4		1*D4			
SPEAKER NUMBER 3							
P+A: MEAN	90.1	96.9	98.7	93.5	91.7	92.4	93.9
S.E.	2.3	0.9	0.6	1.1	1.2	1.4	0.6
DELTA ACT/PRED	8.2/6.2	1.7/0.	1.1/0.	3.7/3.1	1.8/3.1	6.1/9.4	3.8/3.6
	1*D2/1*D5	2*D3					
SPEAKER AVERAGE							
P+A: MEAN	83.9	97.0	94.8	95.6	91.5	93.3	92.7
S.E.	1.5	0.5	0.9	0.6	0.8	0.8	0.3
DELTA ACT/PRED	10.5/9.4	2.3/1.0	2.4/1.0	2.8/2.1	1.7/3.1	5.6/7.3	4.2/3.9

THIS REPORT IS THE AVERAGE OF THE FOLLOWING SYSTEMS
SYSTEM 2673 VER 1 - 3 (09-JUL-86 A;09-JUL-86 B;11-JUL-86)
THIS REPORT IS FOR 8 LISTENERS PER SYSTEM - SPEAKERS JE CH RH

Table 6.9 SET B

SYSTEM 2674 INTERRUPTED DRT BURST WORDS D2A 3M/Q/DYN

	FEATURES						
	V	N	SU	SI	G	C	TOTAL
SPEAKER NUMBER 1							
P+A: MEAN	83.1	98.7	96.1	96.4	92.4	90.1	92.8
S.E.	2.1	0.9	1.4	1.1	1.1	0.9	C.6
DELTA ACT/PRED	3.2/6.2	.8/0.	-3.0/0.	2.7/3.1	2.4/3.1	9.1/9.4	2.5/3.6
	2*D2	1*D4/1*D5					
SPEAKER NUMBER 2							
P+A: MEAN	83.6	96.4	94.5	98.7	90.9	95.3	93.2
S.E.	1.2	0.5	0.9	1.0	1.7	1.2	0.3
DELTA ACT/PRED	15.2/15.6	3.2/3.1	4.2/3.1	0./0.	.4/3.1	3.6/3.1	4.4/4.7
		3*D2/1*D4		1*D4			
SPEAKER NUMBER 3							
P+A: MEAN	92.2	97.1	99.0	93.0	91.9	92.4	94.3
S.E.	0.9	1.2	0.7	1.5	1.5	1.5	0.7
DELTA ACT/PRED	6.1/6.2	1.4/0.	.9/0.	4.2/3.1	1.5/3.1	6.1/9.4	3.4/3.6
	1*D2/1*D5	2*D3					
SPEAKER AVERAGE							
P+A: MEAN	86.3	97.4	96.5	96.0	91.8	92.6	93.4
S.E.	1.2	0.6	0.7	0.8	0.8	0.8	0.3
DELTA ACT/PRED	8.2/9.4	1.8/1.0	.7/1.0	2.3/2.1	1.4/3.1	6.3/7.3	3.4/3.9

THIS REPORT IS THE AVERAGE OF THE FOLLOWING SYSTEMS
SYSTEM 2674 VER 1 - 3 (09-JUL-86 A;09-JUL-86 B;11-JUL-86)
THIS REPORT IS FOR 8 LISTENERS PER SYSTEM - SPEAKERS JE CH RH

For now we will limit our analysis of the data to verification of the existence of the Projected or Follow Through Error effect. For Set A we do not find depressed attribute scores for the various cases of two missing words (D2). For Speaker RH there is no effect found with three missing words (D3) following the attribute Voicing, but there is a possible effect for the attribute Nasality with two three missing word sequences (2*D3) where we have a score that is depressed by 1 DRT point. This corresponds to 17% of the listener crew losing synch for one word each time. The effect is not evident for Speaker RH's total score or for the Nasality score averaged across the three Speakers. These results are consistent across all three word replacement states of Set A (silence, acoustic noise, burst channel noise). There is no evidence of a cascade effect past the first word following a missing sequence. The Voicing score for Speaker RH preceded by a 3 missing word case is also affected by having two Voicing words replaced. This score is not only not depressed, but is greater than expected by 2 DRT points. If the Projected Error effect is present, it is very small for missing sequences up to 3 words.

Set B includes sequences of up to 5 missing words. The same small effect seen with Set A is evident for Speaker JE, acoustic noise, attribute Nasality with sequences of 4 and 5 missing words and for Speaker RH, acoustic noise, attribute Nasality with two sequences of 3 missing words. The effect on Speaker RH could also contain a cascade from the 5 missing word state on Voicing. There may also be a cascade effect evident for RH, acoustic noise, attribute Sustension. All of these effects are of the same size as that found for Set A (i.e. a 17% listener crew synch loss). Similar effects are noted for Speaker CH, silence, attribute Nasality and acoustic noise, attribute Sibilance. There is a major cascade effect across all word replacement states for Speaker CH, attribute Sustension. The effect is equivalent to all listeners missing one extra Sustension test word during four possible cascade situations. The attribute Nasality that should also have been affected if this was a cascade effect is only depressed for the silence state. A closer look at the variability of the listener sustension scores in the System repeats that were averaged, indicates that the 95% C.I. for this score is as large as the measured deviation. This indicates that the cascade effect is as likely not present as it is present.

Elsewhere in the results for Set B there are incidences of inflated scores especially for the attribute Graveness across all word replacement states and Speakers. A possible Left/Right word choice vs word removed bias was checked as a source of this anomaly. This bias was not found to be present. A reason for these inflated scores has not been found. Effects between the silence, acoustic noise, and block error noise word replacement states were expected. It was thought that the presence of any signal rather than silence would help the listeners maintain synchronization. Since the listeners appeared to have kept synch for the silence state, no positive effect for the noise states was found. There may have been an "irritation" effect present with the noise states for the longer replaced word sequences found in Set B.

An extensive Analysis of Variance (ANOVA) across the individual System tests with comparisons to the individual base line System tests shows significant differences at a 95% Confidence Interval (C.I.) for only those attributes that have been modified (i.e. V & C for Set-A; All for Set-B). This analysis was for attribute scores averaged across speakers, however, a significant difference was also indicated for System by Speaker by Attribute interactions. No significant effect was indicated between the methods of word replacement (i.e. silence, acoustic noise, burst noise).

6.1.3 Study Results

The results of this study indicate that "interrupted DRT's" can be carried out by trained listener crews without worry about synchronization or guessing problems. Any method that provides the listener crew with an indication that a word is expected (i.e. forced pacing, visual or audible indicators) would require retraining of the crew and limit any comparisons between past and future testing. It would also further differentiate the RADC DRT facility from other DRT facilities and would require changes in the test tape preparation method. The introduction of a "guess" or "missing word" key to the DEU's would require extensive retraining of the listener crew and could cause listeners to use this key rather that make the fine word pair distinctions that are now required of them. The storage and data transfer of a tri-state variable (i.e. right/left/missing word) would require a complete modification of all DRT System software, file structures and the DRT DB.

6.2 DRT MODIFICATIONS

The adaptation of the DRT that is required is an adjusted scoring method that takes into account the "missing" words. These "missing" words will have to be identified by some process, and decisions about words that are only partially affected will have to be made. With the words identified, a modification to the scoring algorithm can be made rather simply. Since each DRT of this type will have different "missing" words, the procedure to locate them will have to be simple to carry out, yet highly accurate. A time base file for the start of each word in the working master could be used as a mask with the processed tape to flag the "missing" words. An analog tape of the TTL output levels of the BER program could also be used as a mask. ILS could then be used for verification. This process would require that the time mask file and the test tape be input to the RADC Speech DB. The DRT DB would have to be modified to maintain the precision currently available. This is because the DRT DB stores Speaker-Listener interactions summed over attribute test tokens. The range used is +16 to -16 and a constant 100./16. is used to convert scores to percent. With a base number of tokens less than 16, there are quantization levels that can not be represented.

The DRT software and Data Base has been modified to handle "Interrupted DRT Systems." A new version of the scoring routine DRT handles the listener data with the help of a KEY file that defines the missing words. This routine provides adjusted results in report form and transfers the test data to the DRT Data Base. Details of the new DRT program are covered in Chapter Three of this report. A modification of the DB structure allows for the storage of "interrupted DRT Systems" within the existing DB without effecting the storage or analysis of normal DRT system results. Details of the DB modifications are covered in Chapter Two of this report. A new version of the MENU package had to be developed to provide comparative results and analysis between normal and interrupted systems. The changes to the comparative analysis package MENU are covered in Chapter Four of this report.

6.2.1 Results With Modified DRT

The new software was used to score and analyze the interrupted DRT Systems used in this study. What we would hope to see in these corrected results would be Total and Attribute scores by speaker and across speakers that are statistically equivalent to System 2656 and each other. An extensive ANOVA across the individual corrected System tests with comparisons to the individual base line System tests shows no significant differences at a 95% Confidence Interval (C.I.) for system means, attribute means by system, or individual speaker attribute scores by system. As with the uncorrected System results, no significant effect was indicated between the methods of word replacement.

Table 6.10 provides a comparison of all of the interrupted systems given in this memorandum as corrected for missing words by the routine DRT. These results are over the same system averages used in Tables 6.2 - 6.9 and include the averaged results for System 2656 as a base line. These results verify the software packages DRT and MENU. They also show that it is possible to achieve meaningful DRT results for an interrupted system down to at least the Speaker/Attribute score.

Table 6.10
COMPARISON OF DRT SYSTEMS CORRECTED FOR MISSING WORDS
(P+A Mean Scores w/ S.E.)

	FEATURES V	N	SU	SI	G	C	TOTAL
SPEAKER NUMBER 1							
2656	86.2	99.5	93.1	99.1	94.8	99.2	95.3
	0.9	0.2	1.5	0.5	0.9	0.6	0.3
2669	86.5	99.0	93.9	99.0	95.0	99.4	95.5
	1.3	0.3	1.1	0.5	0.9	0.3	0.4
2670	86.7	99.1	94.8	99.4	94.8	99.3	95.7
	1.7	0.5	1.1	0.4	1.2	0.3	0.4
2671	88.2	98.7	95.8	99.2	95.7	99.2	96.1
	2.0	0.7	1.1	0.3	1.0	0.3	0.4
2672	85.8	98.7	92.7	99.2	97.7	99.7	95.6
	1.9	0.6	2.0	0.4	0.3	0.3	0.4
2673	88.3	98.4	94.8	98.6	94.6	99.4	95.7
	1.0	0.9	1.2	0.8	1.1	0.4	0.3
2674	88.8	99.0	96.4	99.5	95.5	99.7	96.5
	1.3	0.8	1.5	0.4	0.6	0.3	0.5
SPEAKER NUMBER 2							
2656	98.8	99.5	98.8	98.8	91.2	98.9	97.7
	0.4	0.3	0.5	0.7	1.2	0.6	0.2
2669	99.0	99.0	98.3	98.2	92.2	98.8	97.6
	0.4	0.3	0.6	0.6	1.4	0.5	0.2
2670	98.6	98.8	98.3	97.8	91.8	99.2	97.4
	0.4	0.6	0.6	0.6	1.1	0.3	0.2
2671	99.1	99.6	98.0	97.9	91.5	98.6	97.5
	0.3	0.2	0.6	0.6	1.1	0.7	0.2
2672	98.8	97.9	98.4	97.9	93.8	99.7	97.8
	0.4	1.1	0.4	0.7	1.6	0.3	0.4
2673	98.0	98.7	96.6	97.7	91.5	99.5	97.0
	1.3	0.6	1.2	0.7	1.8	0.3	0.5
2674	98.4	99.4	98.4	98.7	93.0	98.1	97.7
	0.7	0.4	0.5	1.0	1.4	0.8	0.2

SYSTEM 2656 PDP-11/44 D-2-A DISK MASTER Q/DYN/3M
VER 1 - 5 (20-NOV-85;22-NOV-85;29-NOV-85;09-JUL-86;11-JUL-86)
SYSTEM 2669/I ZEROED WORDS D2A Q/DYN SET-A
VER 1 - 6 (25-JUN-86 A;25-JUN-86 B;26-JUN-86 A;26-JUN-86 B;
02-JUL-86 A;02-JUL-86 B)
SYSTEM 2670/I EC-130 NOISEWORDS D2A Q/DYN SET-A
VER 1 - 6 (25-JUN-86 A;25-JUN-86 B;26-JUN-86 A;26-JUN-86 B;
02-JUL-86 A;02-JUL-86 B)
SYSTEM 2671/I BURST WORDS D2A Q/DYN SET-A
VER 1 - 6 (25-JUN-86 A;25-JUN-86 B;26-JUN-86 A;26-JUN-86 B;
02-JUL-86 A;02-JUL-86 B)
SYSTEM 2672/I ZEROED WORDS Q/DYN SET-B
VER 1 - 3 (09-JUL-86;11-JUL-86 A;11-JUL-86 B)
SYSTEM 2673/I EC-130 NOISE WORDS D2A Q/DYN SET-B
VER 1 - 3 (09-JUL-86 A;09-JUL-86 B;11-JUL-86)
SYSTEM 2674/I BURST WORDS Q/DYN SET-B
VER 1 - 3 (09-JUL-86 A;09-JUL-86 B;11-JUL-86)

NOTE!!! S.E. ACROSS LISTENER BY SPEAKER INTERACTIONS
AVERAGED ACROSS SYSTEMS.

Table 6.10 (Continued)
(P+A Mean Scores w/ S.E.)

		FEATURES					
	V	N	SU	SI	G	C	TOTAL
SPEAKER NUMBER 3							
2656	98.3	98.6	99.8	97.2	93.4	98.6	97.7
	0.6	0.8	0.2	0.8	0.3	0.9	0.2
2669	98.7	97.3	99.2	96.5	94.5	99.0	97.5
	0.6	0.9	0.2	1.1	1.2	0.3	0.2
2670	98.9	97.5	99.7	96.7	93.6	99.1	97.6
	0.4	0.8	0.2	0.8	0.9	0.4	0.2
2671	98.2	96.7	99.9	97.1	94.8	98.7	97.6
	0.4	1.1	0.1	1.1	1.3	0.5	0.3
2672	98.1	98.4	99.5	97.2	93.6	100.0	97.8
	1.2	0.9	0.3	1.2	1.4	0.0	0.4
2673	96.9	96.6	98.7	96.9	95.3	99.0	97.2
	1.5	1.0	0.4	0.7	1.2	0.5	0.3
2674	99.5	97.1	99.0	96.4	94.7	99.1	97.6
	0.3	1.4	0.7	1.3	1.4	0.6	0.3
SPEAKER AVERAGE							
2656	94.4	99.2	97.2	98.3	93.2	98.9	96.9
	1.3	0.3	0.8	0.4	0.6	0.4	0.3
2669	94.7	98.4	97.1	97.9	93.9	99.1	96.9
	1.3	0.4	0.6	0.5	0.7	0.2	0.3
2670	94.7	98.5	97.6	98.0	93.4	99.2	96.9
	1.3	0.4	0.6	0.4	0.6	0.2	0.2
2671	95.1	98.4	97.9	98.1	94.0	98.8	97.0
	1.2	0.5	0.5	0.4	0.7	0.3	0.2
2672	94.2	98.3	96.9	98.1	95.0	99.8	97.1
	1.4	0.5	0.9	0.5	0.8	0.1	0.3
2673	94.4	97.9	96.7	97.7	93.8	99.3	96.6
	1.1	0.5	0.6	0.4	0.8	0.2	0.3
2674	95.6	98.5	97.9	98.2	94.4	99.0	97.3
	1.1	0.6	0.6	0.6	0.7	0.4	0.2

SYSTEM 2656 PDP-11/44 D-2-A DISK MASTER Q/DYN/3M
VER 1 - 5 (20-NOV-85;22-NOV-85;29-NOV-85;09-JUL-86;11-JUL-86)
SYSTEM 2669/I ZEROED WORDS D2A Q/DYN SET-A
VER 1 - 6 (25-JUN-86 A;25-JUN-86 B;26-JUN-86 A;26-JUN-86 B;
02-JUL-86 A;02-JUL-86 B)
SYSTEM 2670/I EC-130 NOISEWORDS D2A Q/DYN SET-A
VER 1 - 6 (25-JUN-86 A;25-JUN-86 B;26-JUN-86 A;26-JUN-86 B;
02-JUL-86 A;02-JUL-86 B)
SYSTEM 2671/I BURST WORDS D2A Q/DYN SET-A
VER 1 - 6 (25-JUN-86 A;25-JUN-86 B;26-JUN-86 A;26-JUN-86 B;
02-JUL-86 A;02-JUL-86 B)
SYSTEM 2672/I ZEROED WORDS Q/DYN SET-B
VER 1 - 3 (09-JUL-86;11-JUL-86 A;11-JUL-86 B)
SYSTEM 2673/I EC-130 NOISE WORDS D2A Q/DYN SET-B
VER 1 - 3 (09-JUL-86 A;09-JUL-86 B;11-JUL-86)
SYSTEM 2674/I BURST WORDS Q/DYN SET-B
VER 1 - 3 (09-JUL-86 A;09-JUL-86 B;11-JUL-86)

NOTE!!! S.E. ACROSS LISTENER BY SPEAKER INTERACTIONS
AVERAGED ACROSS SYSTEMS.

6.3 SUMMARY OF THE INTERRUPTED DRT

This study has found that for high scoring DRT Systems with interruptions of up to 6.5 seconds there is no listener follow through or projected error effect for the DRT as conducted at RADC/EEV. Also, trained listeners can keep synchronized with the word presentation under the test conditions and a modified scoring approach can provide meaningful test results that maintain speaker and diagnostic elements.

Further testing in this area could include measurement of the Follow Through Error for Bandwidth Compressed Speech using the modified word lists as inputs and the testing for this effect with partially removed DRT words. The testing of partially removed words would help in defining the rules for marking a word present or absent from a test tape.

The modified DRT method has been used for the evaluation of the intelligibility of digitally compressed voice communications over severely degraded communications channels. This effort included channel error and transmission delay simulation along with intelligibility testing. The error and delay simulation software is discussed in Reference 10.

6.4 VOCODER CHANNEL DOWN TIME

Experiments with test vocoders and the simulation of severe channel conditions indicate significant periods of time when the receiver experiences unrecoverable bit error states. A muting algorithm within the test vocoder may revert to silence until synchronization and a clear or acceptable error rate is recognized. During these periods of channel down time (CDT) the system has zero percent intelligibility.

The following describes the procedure used to measure the estimated amount of time that zero intelligibility occurred over the test vocoder system with an unknown number of block errors injected in the digital transmission stream (e.g. Channel Down Time). It involves the generation of analog input tapes under error conditions, the measuring of those tapes with an amplitude squared histogram and the comparison of those histograms to one of the systems without block errors. This procedure was carried out at the RADC/EEV Speech Processing Facility.

6.4.1 Data Collection

The test vocoder system is set up in the same manner as for formal DRT testing. The output of an Otari 2-track analog tape recorder is connected to the input of the transmitter. A bit error rate box is placed in the digital bit stream between the transmitter and the receiver. The analog output of the receiver is recorded by another

Otari 2-track. Errors are implemented by a secondary processor (Refs. 7 and 10), that takes data off magtape and sends a bit stream to the bit error rate box. This system is consistent with the PDP-11 implementation used for the formal DRT testing.

The output of a Gaussian noise generator is passbanded between 100 and 5000 Hz and sent to the Otari input deck. The gain is set for a meter reading of -20dbVu and the monitor switch set to source to allow signal pass-through. This is the analog input to the test vocoder system. The analog output is recorded at -20dbVu for error free and block error conditions. Twenty or more minutes of output is recorded for each error condition.

These tapes are then played back, passbanded again from 100 to 5000 Hz and sent to another Otari deck where the filtered, processed white noise is set to -20dbVu when no errors are present. The adjusted signal is passed through to a CSP-30 processor at EEV for measurement of an energy histogram. A 2047 bin amplitude squared histogram program is used to take a twenty minute sample of each error condition. The sampling rate is 10000/sec. The window length used for the rms power calculation is set to 255. Both a graph and a listing of bin values are produced for each error condition including processed white noise in the clear. A sample histogram is presented in Figure 6.2.

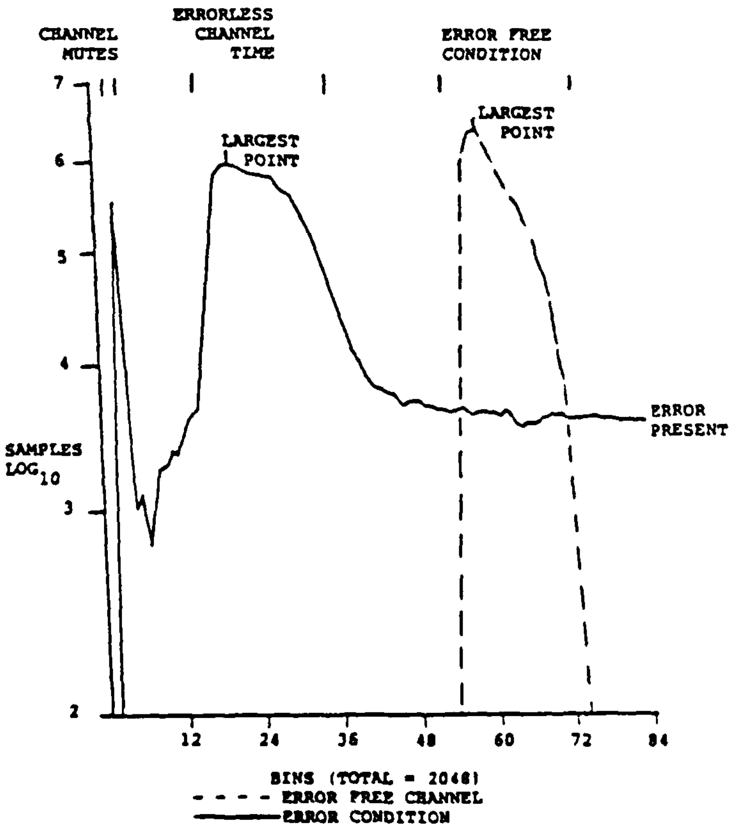

Figure 6.2 Energy Histogram

6.4.2 Data Interpretation

The histogram of the processed, filtered white noise in the clear becomes the baseline for comparison. This histogram will show that all of the samples fall in a narrow segment of 20 bins (54-74) in the lower end of the power histogram. Histograms of error condition tapes will show the same tendency but with many samples in bins outside of the given range. For all conditions the vast number of samples will be error free. Because of this the bin with the greatest number of samples in each histogram can be used to correlate the error condition with the error-free condition.

For the test vocoder in the above example, the error free histogram's largest point was bin 58. There were 4 lower power bins and 15 higher. On the histograms of error conditions, the sum of the bins that surrounded the largest point in the same manner (4 low, 15 high) was calculated. Since all analyses were calculated over the same input time (20 min.), the total number of samples is constant and gives a normalization value. The difference between the total samples in the error free state and the samples within the 20 bin range of an error state was interpreted to be a measure of channel down time. Given the nature of the error conditions, highly concentrated bursts, samples above the 20 bin range, were interpreted as error-present conditions and lower power samples as silence caused by the muting algorithm. The histogram difference over these bins divided by the total number of samples gave the percent Channel Down Time.

CHAPTER 7

FIELD INTELLIGIBILITY SYSTEM TESTING

7.1 IN-FIELD DIAGNOSTIC RHYME TEST (FDRT)

There has long been a reluctance by operational personnel to accept the results of laboratory measures of parameters such as the intelligibility of a communication system. The inability to totally model the environment of an aircraft in flight has been considered a reason to doubt results of tests like the DRT. The fact that the controlled nature of a normal DRT is what limits the context of the test and allows the accurate measurement of a subset of variables is not well understood by many.

In early 1984 the ARCON research staff felt that a field measure of intelligibility could be made, but that the accuracy of the field measure would be less than that of the laboratory measure. A March 1984 ARCON memo to RADC/EEV detailed some ideas for an In-Place DRT Procedure using the TRS80 M100 Data Entry Units (DEU). The goal was to have Speakers and Listeners in various environments, both on the ground and in the air, communicating over actual Air Force channels conduct a modified version of the DRT. To facilitate this testing, the RADC/EEV Data Entry System would be modified for field use. Portable audio tape recorders would be used so that results could later be verified with normal in-house DRTs.

The limitations of the In-Field DRT include a limited set of non-standard listeners and speakers, no control of the transmission medium and dependence on other organizations to provide the aircraft platforms and communication systems for test. The idea was well received and it was decided to utilize this method during an AF Electronic Systems Division (ESD) communications system evaluation scheduled for that summer.

Over a four month period ARCON provided support to this evaluation project that included the following:

1. SPEAKER Word List Presentation Software
2. LISTENER DRT Software
3. Development of data transfer and analysis software
4. Assistance with experimental design
5. Definition of the DRT Field Equipment Set
6. Training of ESD and RADC speaker/listeners
7. Generation of field training procedures of operational speaker/listeners
8. Development of Procedures for processing results
9. Processing of Field data
10. Verification analysis of the In-Field DRT

Extensive field tests and surveys were conducted by ESD and RADC personnel. An accelerated testing schedule and untested software caused early problems. Although Field test procedures were well thought out and documented, field data was incomplete because of equipment malfunctions ranging from voice processor failures to aircraft assignment difficulties. Program schedules were unrealistic and baseline data was unattainable from some listener/speakers because of their other commitments. All of these problems resulted in the inability to verify or even relate the field test results to in-house tests made on audio recordings returned from the field.

The basic experimental design, *DRT Field Equipment Set*, test software and field procedures as specified for this effort were not at fault in the inability to verify the relationship between In-Field and in-house DRTs. The mixed task objectives of validating the test method and evaluating a specific communication system were primarily responsible for the failure to accomplish either. They led to unclear areas of responsibility and a low priority for the DRT component of the overall field test.

To facilitate this testing, the system used for taped DRT's at the RADC/EEV Speech Lab was modified. This report will document the adaptations made to existing software in support of this effort. The source code for the Field DRT software package is available from RADC/EEV. The DRT field equipment set used in the ESD survey will be discussed. The transfer of data and programs to/from the Data Entry Units was cumbersome. Later, a new method for downloading programs to the DEUs was developed. This method will also be discussed.

7.1.1 Software Development

One of the major differences between taped and live DRT's is the possibility of loss of communication between Speaker and Listener(s) during live tests. This eventuality must be allowed for by the software, and recovery must be relatively straightforward. Also, it must be recognized that in a communications setup involving "push-to-talk" microphones, for relatively long periods of time the Speaker will be unable to verify with the Listener(s) that he is still in fact being heard. Finally, some method must be provided for the Speaker to be presented with the proper words to speak, with the right time interval between words.

These considerations were dealt with by providing two programs to be run on Radio Shack TRS-80 Model 100 portable computers. These are the same machines used with the taped DRT sessions. The two programs are LISTEN.BA and SPEAK.BA. LISTEN is a modified version of the DRT.BA program used for taped DRT's, while SPEAK was written for this project. Both programs include a facility for repeating a page of a DRT wordlist (i.e., 58 word-pairs) in the event of loss of communications.

LISTEN Program - LISTEN is a modified version of the program DRT, which was originally written for the taped DRT sessions. Since DRT is fully documented elsewhere, this section will describe only the changes made.

The major difference between the two programs is the inclusion in LISTEN of the facility to restart a page of a wordlist. The assumption made is that the Speaker will hold down his "push-to-talk" button for the duration of one page (58 words) of the current list. He will then ask the Listener(s) whether or not all of the page was heard. If communication was interrupted, the Listener(s) can request a repeat of that page. Otherwise the test continues with the next page.

If, during the course of a page of a DRT, communication is interrupted, the Listener need not finish that page in order to have the program restart it. At any time, the Listener can hit the Left Arrow key on the M100 keyboard. This is the signal to LISTEN that the current page should be restarted. The program immediately jumps to a subroutine which displays the approximate number of seconds left before the Speaker finishes the page. At any time, the Listener can restart the page by hitting any key. Presumably this will be done when communication is re-established and the Speaker is made aware of the necessity to repeat. This procedure can be repeated any number of times for any one page of the test. Once a page has been accepted as complete, that data is stored, and the page is no longer repeatable.

There are only three other differences between LISTEN.BA and DRT.BA. The first is that in LISTEN.BA no assumption is made regarding the number of systems or speakers to be heard. Therefore, before each booklet is started, the Listener is prompted for one wordlist number and one speaker I.D. In DRT.BA, it is assumed that three speaker/wordlist combinations will be run at a time, so all three are prompted for at once.

Another minor change was that, while the same Listener can be expected to use the same M100 for an entire day's testing with taped DRT's, the same is not necessarily the case for live tests. Therefore, instead of storing responses in a file tagged with the Listener's ID number as in DRT.BA, LISTEN.BA appends each booklet's answers to one file, ANSWER.DO.

The last difference between the two programs is that the two original wordlist files used by DRT.BA, WORD.DO and PROBE.DO, are broken up into first and second halves for LISTEN.BA (WORD1.DO, WORD2.DO, PROB1.DO, PROB2.DO). This was done to speed up the process of backing up to the top of a page when a restart is requested.

Except for the differences noted, LISTEN.BA operates in the same way as DRT.BA. Word pairs are displayed in the same manner, responses are accepted and stored in the same format, and the same options regarding training states, reverse video, etc., are present.

<u>SPEAK</u> <u>Program</u> - The program SPEAK.BA was written specifically for this application. It is based on DRT.BA, but its purpose is to display a list of DRT word pairs for a DRT speaker. SPEAK allows the user to select the wordlist key from a set of such keys stored in file KEYLST.DO. The time interval between words may also be chosen, with a default of 1.3 seconds. SPEAK then displays the indicated word pairs, scrolling through the list at the specified rate. At the end of a page, the Speaker is given the opportunity to either continue to the next page or repeat the page just completed. At this point the Speaker inquires of the Listener(s) whether or not he should continue, and proceeds with the appropriate page. This process continues until the end of the current list, and can be repeated indefinitely.

SPEAK.BA consists of four sections: Initialization, Prompt/Response, Wordlist Display, and Subroutines. These are outlined below.

<u>Initialization</u> <u>Section</u> - This section is executed at program startup. The screen is cleared, the maximum number of files to be used declared, string space is allocated and initialized, memory is allocated for the MCODE.CO machine language subroutines and MCODE is loaded, and several variables are initialized.

Prompt/Response Section - In the Prompt/Response Section, the parameters of the test are input by the user and stored by the program. All answers given in this section are echoed back to the Speaker for verification. If the Speaker indicates the data is correct, the next question is asked. Otherwise the last question is asked again.

The Speaker is asked first whether the list to be used is the Probe or Data list. The response must be either "P" or "D", or "E" for exit. Then the Speaker's ID is entered. The expected format is two initials. Next a list of available keys is displayed. The keys determine which word of a given word pair is to be spoken. The Speaker is asked to select one of the keys, and this is checked for validity against the list displayed. If valid, execution proceeds to the next question, otherwise the Speaker is prompted for a new key.

Once the key has been selected, the Speaker is given the option of changing the delay period between words. The default of 1.3 seconds is selected by entering a carriage return, but any period down to .52 seconds may be selected. This choice is made available for training purposes.

After all of the above has been entered, the Speaker is instructed to read a standard DRT prologue message containing the Speaker's ID, the wordlist key, and the date. When the speaker hits carriage return, the program branches to the wordlist display section.

Wordlist Display Section - This is the section which displays the wordlist and changes the "current" word pair at the specified interval. The LCD screen consists of 8 40-character lines. At the beginning of a page, the wordlist and page number are displayed on line 1. From that point on however, lines 1 - 4 are blank. Line 5 contains the "current" word pair. This pair has the word which is to be spoken on the left side, highlighted in reverse video. Line 6 is blank, and lines 7 and 8 contain two upcoming, or "future" word pairs, all in normal video.

At the specified time interval, the display scrolls upward. The contents of line 5 disappear, and the contents of line 7 are moved to line 5, with the lefthand word re-written in reverse video. This becomes the next "current" word pair. At the same time, line 8's contents move to line 7, and a new pair appears on line 8. Lines 1 - 4 and line 6 are always blank.

This scrolling process continues until the end of a page is reached (a page is defined as 58 word pairs). At this point, a message is displayed indicating end-of-page, and the Speaker is instructed to obtain Listener acknowledgement before continuing. If the page just completed is to be repeated, the Speaker enters an "R"; to proceed with the next page, the Speaker enters a "P". This process continues until the 4-page "book" is completed. The program then jumps back to the Prompt/Response Section and starts again.

Subroutine Section - This section contains various subroutines called in the other sections. Subroutines exist to display the End-of-Page message and input the option to proceed or repeat, to form the next word pair from the keylist and wordlist, to display the KEYLST.DO file and obtain the Speaker's selection, and to check that selection for validity.

KEYLST.DO File Format - The file KEYLST.DO is needed for correct operation of SPEAK.BA. This file contains the list of available keys for use in deciding which word of the "current" pair should be spoken. This file consists of 63-byte records which have a 5-byte key identification followed by a 58-byte key. The key ID is of the form "Wnnna", where "nnn" is a 3 digit number, and the "a" is either "A" or "B". The key is just a string of zeroes and ones indicating whether the left hand or righthand word should be spoken. This key is used once per page. On pages one and four, a one indicates that the first word of a pair should be spoken, while a zero means the reverse. On pages 2 and 3, a one indicates that the second word of a pair should be spoken, while a zero shows that the first word of a pair should be spoken.

Modifications To The "MCODE" Machine Language Subroutines - SPEAK.BA and LISTEN.BA use some of the machine language subroutines written for the DRT.BA program. In the case of the LISTEN program, one modification was necessary to one of MCODE's routines. The original DRT.BA program passed three integers to the keyboard polling routine. These were used as flags to determine whether the Listener made a left/right word choice, or whether a change in a past selection was indicated, or whether the position of the change indicator should be moved. The status of these three flags indicated what action the program should take. LISTEN.BA uses a fourth flag which indicates whether or not the current page should be restarted. The machine language subroutine INIT was modified to store the location of this fourth flag, and the KBD keyboard monitoring routine was changed to recognize this key and report its status.

7.1.2 Equipment

ARCON defined the following items for the DRT Field Equipment Set during the 1984 AF ESD communications system evaluation:

1. 4 Sony TC-D5M Audio Cassette recorders
2. 2 Sony ECM-16T Electret Condenser Microphones
3. GenRad 1565 Sound Level Meter
4. 4 Radio Shack TRS-80 Model 100 computers
5. 2 Radio Shack Minisette-9 Data recorders
6. Speaker/Listener Training Program on Audio cassette
7. Backup Programs for M100s on Data cassette
8. Headphones
9. Batteries (AA's and C's)
10. 2 Interface boxes
11. Blank Audio and Data cassette tapes
12. Cables, and Adaptors

One audio cassette recorder was interfaced to the communication system at each station to record either transmit or receive lines at both the pre and post intercom position (Fig. 7.1). Adaptor cables and a simple interface box designed for this specific application, allowed test participants to easily switch and adjust channels and recorder input levels. During transmission, the speaker's recorder would be accessing the headset output and the intercom output. When receiving, a listener's recorder would access the vocoder output and the intercom output. A backup recorder was available at both stations. Tapes recorded on site could then be evaluated at the RADC/EEV Speech Lab by the in-house listening crew.

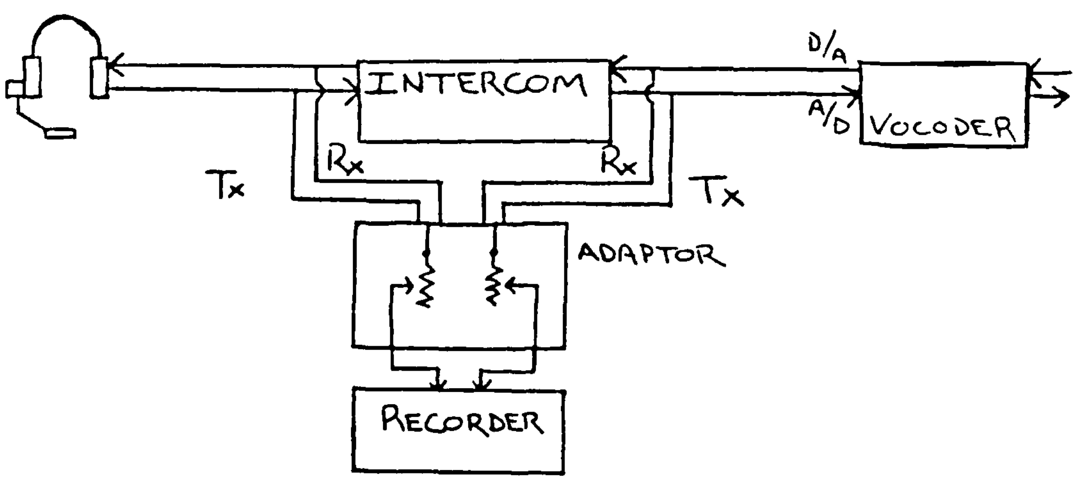

Figure 7.1 Field DRT Recording Configuration

Recordings of the ambient noise environment were generated using a separate (backup) recorder and the two Sony mics. Sound level measurements were also made with the GenRad meter at "A","B" and "C" weightings to coincide with these noise recordings.

Two Model 100 computers were brought to each station. One machine configured for speaking, the other for listening. The Data recorders were used to store listener response data. The Model 100 computers' listener data files were downloaded onto cassette at the end of each test day. Backup copies of all the necessary M100 programs were recorded at RADC/EEV prior to field testing on Data cassette and these could be uploaded to the M100s from the Data recorders.

An audio cassette copy of the training series used for the RADC/EEV Speech Lab's in-house listening crew was brought to train field listener/speakers. A large supply of high-quality batteries was needed to insure ample operating time for all portable equipment. Headphones allowed the monitoring of tape decks during preliminary testing and throughout the DRT testing and noise measurement efforts to maintain quality tape recordings.

7.1.3 Program Download Procedure

Software and data can be transferred to/from a Model 100 DEU through either the RS232 port, the cassette recorder connector or a floppy disk drive. The field tests depended entirely on cassette recorder data and program transfer. This proved to be time consuming and unreliable. The incorporation of a Tandy Disk/Video Interface should solve this problem, however, an even faster method to initiate M100s has been developed and will be documented here.

Once a single Model 100 is loaded with the proper Speaker programs and a second is loaded for the Listener, a program to cross-load from these M100s to others is faster than loading each M100 from the RS232 or cassette recorder ports. A pair of programs called MLOAD and XLOAD allow cross-loading from one M100 to another via the RS-232C communications ports. The two machines must be connected by a "null-modem" cable. When this program completes execution, the "destination" machine has an exact copy of the "source" machine's RAM, including all BASIC, document, and machine-language files. The program does not set the clock on the destination machine. Each machine keeps a count of any comm errors. The BASIC program will print the final error counts on both machines to verify that a load was successful, or advise that the load failed and should be reaccomplished.

To load one Model 100 from another first ensure that the "source" machine has a copy of the BASIC program "XLOAD.BA" in a RAM file. Then connect both machines with an RS-232C "null-modem" cable in the RS-232C connectors on the back of both computers. Place both machines in the BASIC command mode by selecting BASIC from the main menu. On the source machine type:

```
RUN "COM:98N2E"<enter>
```

On the destination machine type:

```
LOAD "XLOAD"<enter>
SAVE "COM:98N2E"<enter>
RUN 1<enter>
```

Wait 45 seconds and then check the error counts printed by both machines. If both error counts are zero, then the cross-load was successful. Otherwise, repeat the above procedure until both machines report zero errors. The program should not fail, so repeated failures may indicate a hardware problem in one or both machines.

The cross-load program does not require that the destination machine be zeroized, only that it not be "hung-up" or "crashed". The program does not initialize the Date/Time Clock on the destination machine. DATE$, DAY$ and TIME$ may be set in the normal manner either before or after cross-load is completed.

The source code for the programs MLOAD and XLOAD are available from RADC/EEV.

CHAPTER 8

DRT/DAM MASTERING PROGRAM

ARCON Corporation has supported the DoD Digital Voice Processing Consortium (DDVPC) in their Test and Evaluation efforts for the past five years. As part of this effort ARCON personnel have been responsible for the development of a version of the DRT/DAM input master library on digital audio. The Test and Evaluation Facility at RADC/EEV has been used for the research, development and implementation of a system to measure Speech-to-Noise ratios and electrical levels on audio tape (Refs. 7 and 11). This method has been used to equalize the DRT/DAM master tape library in conjunction with converting the library to digital audio on video tape. The end result is a library with equalized presentation levels and measured speech-to-noise values for all speaker/list/channel combinations. Digital audio has allowed the library to be precisely and uniformly edited. Each speaker has been listed with its beginning time code value to make location within the master a simple task. Digital Audio has captured the DRT/DAM library accurately within its 20 to 20,000 Hz. flat frequency response and has also given the library a better storage life than its analog predecessor. This new media also allows the creation of digital working copies that lose no quality even over repeated generations. ARCON has been responsible for the equalization and digital mastering of the entire DDVPC master tape library over the past four years. This project is now complete.

8.1 DIGITAL MASTER LIBRARY

Master tapes of the DRT/DAM digital audio library reside on U-matic videocassette. Each tape contains a single three speaker group of a common gender in a particular noise environment. Speaker/lists are recorded on two channels using two different microphones. Most often, Channel Left will be the resident microphone of the particular noise platform and Channel Right will be the Altec 659A dynamic microphone.

The Altec is a high-quality, full frequency, omni-directional mic. Appendix A is a complete listing of the DRT/DAM digital audio input tape library. Major groups are organized by noise environment and microphones and sub-grouped by speaker sex. Included are speakers, lists and speech-to-noise ratios for each speaker/list/channel. Information regarding the procedures and equipment used for the original production of the analog master tapes can be found in References 12 and 13.

8.1.1 Tape Format

The U-matic digital DRT/DAM master series tapes follow this format:

1) 30 seconds of silence (SMPTE time code 0-30 sec.)
2) Reference tone: 1KHz at +5dB Vu
3) Reference tone: 5KHz at 0dB Vu
4) Speaker 1 DAM list announcement
5) Speaker 1 DAM list
6) Speaker 2 DAM list announcement
7) Speaker 2 DAM list
8) Speaker 3 DAM list announcement
9) Speaker 3 DAM list
10) Reference tone: 1KHz at +5dB Vu
11) Reference tone: 5KHz at 0dB Vu
12) Speaker 1 DRT list announcement
13) Speaker 1 DRT list
14) Speaker 2 DRT list announcement
15) Speaker 2 DRT list
16) Speaker 3 DRT list announcement
17) Speaker 3 DRT list

DAM lists are mastered once for each speaker group/environment. Each master containing DRT scramblings for a particular speaker group/environment has an exact digital dub of the DAM lists. This assures consistent input material for DAM test generation regardless of which DRT scrambling is used. Each list is separated from the next announcement by 10 seconds. Each master has its own index complete with list numbers and clock values to enable use of the auto locator function to find desired sections.

8.1.2 Label Format

The titles of the digital audio library masters were developed by RADC/EEV and differ from their analog predecessors only in the first letter prefix. Table 8.1 is a comparison of old and new titles.

Table 8.1
Master Tape Titles

ANALOG VS. DIGITAL DRT/DAM MASTER TITLES

Noise Environment		Analog	Digital
Quiet	(males)	R-1-A	D-1-A
	(females)	E5-1.1-A	D5-1.1-A
Helicopter	(males)	G-2-A	N-2-A
	(females)	G2-1.1-C	N2-1.1-C
Shipboard	(males)	G-3-A	N-3-A
	(females)	G3-1.1-C	N3-1.1-C
Office	(males)	G-4-A	N-4-A
	(females)	G4-1.1-C	N4-1.1-C
E-3A Aircraft	(males)	K1-1.1-A	J1-1.1-A
	(females)	K1-1.1-C	J1-1.1-C
Destroyer	(males)	K5-1.1-A	J5-1.1-A
	(females)	K5-1.1-C	J5-1.1-C
Helicopter Carrier	(males)	K6-1.1-A	J6-1.1-A
	(females)	K6-1.1-C	J6-1.1-C

Other Noise platforms previously using the "K" prefix (P-3C Aircraft, Jeep, Tank, and E-4B Aircraft) have also been converted to "J" prefixes.

The title of a Digital DRT/DAM master is displayed on the spine of the U-matic tape box. On the front the title is redisplayed along with a description of the noise environment, the microphone channel assignments, the number and gender of the speaker set, and the master serial number. Front Labels appear in the following format:

DRT J10-1.1-A E4B BATTLESTAFF
THREE SPEAKER MALE
CH L. ROANWELL 240100001
CH R. ALTEC 659A DYN.
SERIAL # 00000145

SEE INSERT FOR DETAILS

On the inside front cover of each tape box is the insert. This gives the speaker initials, the lists used and the time code values for each of the lists and reference tones. These inserts appear in the following format:

DRT TAPE J10-1.1-A
E4B AIRCRAFT, BATTLESTAFF COMPARTMENT

TIME CODE MIN:SEC	SPEAKER	DAM LIST
00:30	REFERENCE TONES	
00:50	RH(M)	6A
02:20	JE(M)	3A
03:50	CH(M)	4A
05:20	REFERENCE TONES	
	SPEAKER	DRT LIST
05:40	RH(M)	323A
11:50	JE(M)	314B
18:00	CH(M)	309B

DIGITAL COPIES OF ANALOG MASTERS

The footnote was included to differentiate between lists copied from the analog library and those rerecorded direct to digital (as in the case of some of the quiet environment DAM lists).

The DRT/DAM digital master library's primary use in the immediate future will be for the production of high quality working copies. Direct digital copies will retain all the consistency and response of the original masters. Analog working copies will also show improvement in speaker level consistency and universal formatting. The RADC/EEV facility currently has the capability of generating reel-to-reel analog and Beta videocassette digital working copies. Past experience shows that VHS videocassette copies are easily produced as well.

8.2 MASTERING SYSTEM

Original master tapes are played back on an AMPEX 1/2" four track recorder. The two tracks designated to be digitized are sent through independent attenuators that provide up to 111 db of passive padding in .1 db increments. That output runs to the PCM mastering system. The analog output of that system flows to an Otari MX50-50 recorder. This recorder's output is sent to a passive band-pass filter set. A transformer is inserted to provide line isolation and the signal flows through it to the PDP 11/34 (see Fig. 8.1).

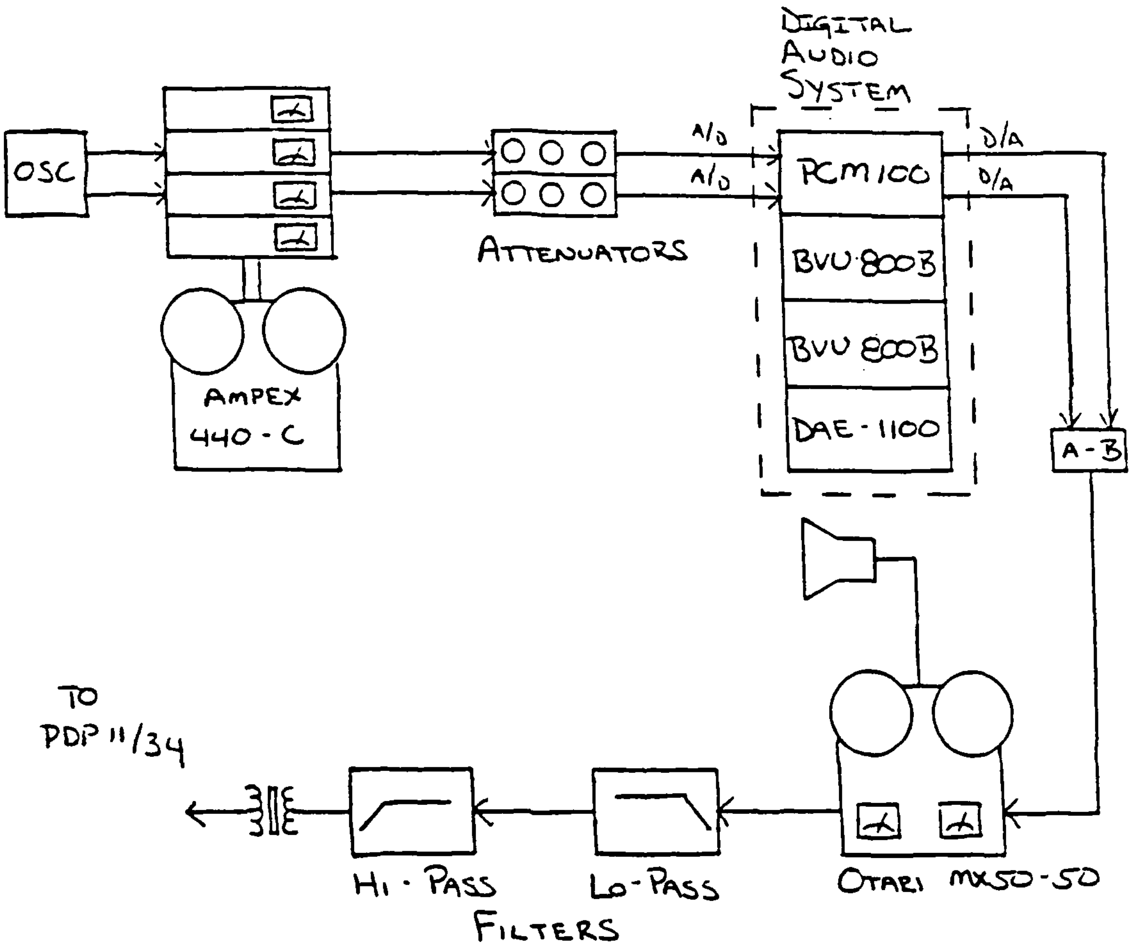

Figure 8.1 RADC/EEV Digital Audio Mastering System

8.2.1 Analog Source

The analog tape recorder used for the playback of the original analog DRT/DAM masters is an Ampex 440-C. This machine matches the one used in the recording of these masters. A headphone monitoring jack is available for each channel.

8.2.2 Digital Audio

The PCM mastering system consists of a PCM-100 digital audio processor, a DAE-1100 digital audio editor, and two BVU 800B professional U-matic videocassette recorders. This system converts the two analog channels to digital, records onto videocassette, edits, and outputs two channel analog. A stereo headphone monitoring jack is available. All components of the digital audio editing system are interconnected according to instructions and illustrations in the DAE-1100 operation and maintenance manual (Ref. 14).

The four switches on the face of the Digital In Out Unit within the PCM-100 are to be set as follows for recording analog information entered via the Analog In cannon plugs. This also allows output from the Analog Out cannon plugs. The output occurs whether the record deck is engaged or not.

EXT SYNC:	INT
REC DATA:	INT
PB DATA:	INT
REC MASTER:	REC

The dubbing switch of the Analog Digital Convert Unit is in the off position. The emphasis switch is set to off during the initial calibration and engaged during measurement and recording of speech material.

Emphasis is a form of high-end boost that conditions the incoming analog signal to ease conversion to digital. By amplifying the upper audio frequencies, samples of these smaller waveforms are more realistically represented. Upon playback, circuitry automatically detects the presence of emphasis and readjusts the analog output accordingly. The increase in input signal strength due to emphasis is reflected in the PCM-100 program meters, although the output has been equalized. This is to guard against saturation of the A/D. In light of this, all reference tones have been adjusted and recorded without emphasis to allow a direct and accurate meter reading.

The Digital Audio Mastering System converts the analog signals into EIAJ 14-bit digital with SMPTE time codes. Sampling frequency is 44.056 kHz. Quantization is selectable between 14-bit and 16-bit linear. Coding formats are the EIAJ standard for 14-bit and a Sony 16-bit format. In Air Force applications, the standard 14-bit format is used. This allows the playback of these recordings through all PCM processors using the EIAJ decoding. Although the 16-bit format allows 4db more dynamic range and slightly less harmonic distortion, the error correction circuitry that the extra two bits were taken from is more important for successful storage and dubbing (Ref. 15).

Sony PCM digital audio systems boast a near flat response from 20 to 20,000 Hz. This specification was confirmed with spectral analysis at the RADC/EEV Speech Lab. Samples of input and output signals showed no significant difference in the frequency spectra of the two sources in the 20-20K Hz. bandwidth.

Digital audio information is converted to a video signal and recorded onto U-matic tape. One of the two analog bands on the cassette is used for SMPTE time code. The PCM system for videocassette overlaps channel information in such a way that, once recorded, it is impossible to digitally separate the two tracks. The relative balance between left and right tracks at the time of recording is preserved. Only by converting to analog may the signals be exclusively manipulated. The digital mastering system also allows the user to inscribe an 8 digit number within the digital code. RADC/EEV has elected to use this User Bits function to inscribe a serial number for each of the DAM/DRT master modules.

Tapes generated on the PCM Digital Audio Mastering System are compatible with any other processor conforming to the EIAJ 14-bit standard or Sony's 16-bit format. However, because the storage medium used is videocassette, another variable arises, that is the video waveform. Digital tapes originating from most European organizations will not be compatible with RADC/EEV equipment due to Europe's vastly different television waveform standard (Ref. 16).

8.2.3 Analog Output

The two analog channel outputs of the PCM-100 meet a switching box just prior to the input of the Otari analog tape recorder. The throw of the switch determines which channel is to be monitored and measured.

The Otari MX50-50 two-track analog recorder is primarily used as a line amplifier. The deck is set to monitor line input and the input gain control is calibrated in order for the PDP 11/34 to properly measure the EPL and S/N ratios (see Reference Tones). The Otari also provides a useful point to monitor the audio signal before filtering. A speaker has been included in the system configuration for this purpose.

The bandpass filter set used as anti-aliasing filters for the PDP 11/34 A/D is manufactured by Allison Labs and is model 2-BR. The low cutoff is set at 150 Hz. and the high cutoff is at 4000 Hz. Before reaching the PDP 11/34's A/D the signal passes through a transformer for the purpose of line isolation.

The PDP 11/34 has an A/D with an 8000/sec. sampling rate. Sampling begins when the space bar of the terminal is pressed and continues for forty seconds. Sampling begins directly after the first word or sentence in the DRT or DAM list. Results are output to the terminal screen with an option to dump to a printer.

Measurements of the analog master tape library show widely varying presentation levels not only across different tapes, but also across different speakers within a single master. It is not uncommon to find differences on the order of 6dB between one speaker and the next, even using the same microphone channel. The digital library has equalized presentation levels to within 0.5dB.

8.3 MASTERING PROCEDURES

The first step in the digital mastering of the DRT/DAM library is to calibrate all parts of the system for unity gain. Initial measurements of the analog masters are made by allowing the signal to flow through the entire system. An accurate result depends on equal levels throughout the system. After preliminary measurements,the channel attenuators are adjusted and new measurements are made. Once the 0dB EPL figure is reached the DRT or DAM list is recorded in a rough format onto U-matic videotape. The rough format is edited into a final finished format with continuous SMPTE time code, a serial number, and a consistent speaker/list announcement format.

It is highly recommended that the operation manuals be read carefully before any attempt is made to use this digital audio editing system (Refs. 14, 15, 17, 18).

8.3.1 Initial Calibration

A 1Khz sine wave input to the Ampex is adjusted so as to give a 0Vu reading on the recorder's track meter being assigned to the PCM-100 channel left. This signal passes through the attenuator which is set to give 15 db of padding. The input level of the PCM system is adjusted to offset that 15 db and give a reading of 0Vu on the PCM-100 meter(emphasis disengaged). The line level at the Otari is also set to 0Vu. In this state, the system provides up to 15 db of boost or over 85 db attenuation of the analog master signal before digitizing. The procedure is repeated for the analog track assigned to the PCM-100 channel right.

8.3.2 Measuring

Master tapes are played back on the Ampex with their reference tones set at 0Vu. The signal flows through the system and is measured by the EPL-S/N program implemented on the PDP 11/34. The 11/34 is manually triggered to begin sampling directly after the first word of the DRT list (in the case of DAM lists, the 11/34 is triggered directly after the first sentence is completed). The emphasis circuitry of the PCM-100 is activated before measuring begins. Sampling continues for forty seconds and is then automatically terminated.

The resultant EPL value determines the amount of boost/cut necessary to reach the 9db EPL target figure. The Attenuator system is adjusted accordingly and the material is remeasured. This process is repeated until the 9db figure is reached. The speech material is then digitally recorded. A hardcopy of the data generated from the analog master presented at its original level and the final digital version are produced.

8.3.3 Digital Recording

All manipulations of the digital audio mastering system take place at the remote DAE-1100 Keyboard. The order of operations for recording of audio signals presented at the analog inputs of the PCM-100 are as follows:

In the editor section, press Recorder. This assigns the video out of the PCM-100 to the U-matic videocassette deck designated as Recorder. Insert a blank U-Matic cassette into the recorder VCR. Be sure to take up any slack by turning the reels clockwise manually. Press CUT IN REC and FWD on the keyboard. The Recorder VCR will now engage and the display will begin incrementing as the time code progresses. It is necessary to record 20-30 seconds of time code before any audio material. The analog ch. 2 of the recorder VCR is used for SMPTE time code and its Vu meter should be deflecting to 0Vu. The SMPTE generator does not halt when the recording function is disengaged.

> WHENEVER TAPE IS STOPPED AND RECORDING RECOMMENCES, 20-30 SECONDS OF SMPTE TIME CODE MUST BE RECORDED BEFORE ANY DIGITAL AUDIO INFORMATION. FAILURE TO DO THIS WILL RESULT IN AN INABILITY TO EDIT.

It is not necessary to have continuous code throughout the tape, however, the values should continually ascend and there can be no more than twelve hours difference between two adjacent sections.

Along with audio information and SMPTE time code, there exists the possibility to record a series of number values called user bits. These bits allow the user to record a unique number value between 0 and 99999999 to coincide with any tape or portion of tape desired. This value may be viewed during any slow transport speed, including shuttles. Simply press the User Bits button and the Hold button in the recorder section (you must have a tape in the recorder to engage this function), the right-most digit of the recorder display will blink and you may select your eight-number pattern from the row of numeral buttons at the top middle of the keyboard. Press the Hold button again when the pattern is complete. These user bits will be copied continuously on any tapes recorded on until the editing system is shut down or the user bits reset.

8.3.4 Editing

The Sony digital mastering system edits in a tail-to-head fashion. Aside from the above mentioned note on SMPTE time code, the only prerequisite is a continuous length of time code on the destination tape (Recorder). The editing system has a preroll function that uses the SMPTE time code to rewind to 5, 10, or 30 seconds before the edit point (user selectable). There must be a continuous length of time code to meet the desired preroll length on both source and destination tapes.

During editing the four switches of the PCM-100 must be configured as follows:

EXT SYNC:	INT
REC DATA:	EXT
PB DATA:	EXT
REC MASTER:	REC

This allows the processor to access data from the video decks rather than from the analog inputs.

Insert a blank cassette into the VCR assigned as recorder. Record the introductory time code. Rewind and playback. Select an edit out point by pressing the Edit Point Out button in the editor section of the keyboard. Once an edit button is pushed, the editor dumps 3 seconds from either side of that point into memory. From here, the 6 seconds may be monitored aurally at normal or half speeds and visually seen as points on a time line. With the manual control the 6 second fragment can be manipulated at any speed. When the exact spot is found the edit point may be locked by pressing Manual and Edit Point Out simultaneously.

Load the rough format EPL equalized Digital cassette into the VCR deemed as player. Press the Player button in the editing section of the keyboard. Start the player forward and select the edit in point by pressing the Edit Point In button. Once again the editor will dump 3 seconds from either side of that point into memory.. Use the search modes to pinpoint and lock in by pressing Manual and Edit In simultaneously.

With both edit points memorized,press Preview. This gives a dry run of the edit. If the splice is unsatisfactory, The Time Offset function may be used to move either point up to + or - 30 seconds. Any number of previews and time offsets may be made. Once a desired edit is found, press Auto Edit and Preview. The recording will be generated the same as the last preview. Once all the desired material has been rerecorded, pressing Pause in the player section will halt both decks.

A continuous series of tail-to-head editing can be performed in this manner. The editor automatically prerolls and synchronizes time code to insure a continuous SMPTE reference. User bits do not transfer during editing nor do they match the recorder tape's value. User bits must be reset prior to recording. Emphasis information is transferred during editing

Once an edit is complete a review can be made by simply pressing the Review button. This automatically shuttles the record deck back to the preroll position of the last edit and plays from there through the edit point and continues.

8.3.5 Analog Source Tapes

The original analog DRT/DAM master tape series resides on 1/2" 4-track tape stored on ten inch reels. Tape speed is 15 inches/sec. Tapes are recorded and played back with NAB equalization. Most of the masters have track assignments that consist of the primary microphone on two tracks, an Altec 659A Dynamic microphone track and a Grayson-Stadler Throat Mic track. Most of the analog masters have the following information in the following order:

1) 1 KHz reference tone
2) Vocal announcement of tape title, environment, speaker number and gender, and primary microphone. (primary microphone channel only)
3) 1 KHz reference tone
4) Speaker 1 DRT list announcement
5) Speaker 1 DRT list
6) 1 KHz reference tone
7) Speaker 2 DRT list announcement
8) Speaker 2 DRT list
9) 1 KHz reference tone
10) Speaker 3 DRT list announcement
11) Speaker 3 DRT list
12) Speaker 1 DAM list announcement
13) Speaker 1 DAM list
14) Speaker 2 DAM list announcement
15) Speaker 2 DAM list
16) Speaker 3 DAM list announcement
17) Speaker 3 DAM list

DAM lists and announcements only appear on the tapes of the first DRT scramblings for that particular speaker set/environment combination. Only the first reference tone on the masters is used to set playback level for the entire tape. Subsequent reference tones vary widely between themselves and their relationship to the speech material.

8.3.6 Reference Tones

It is imperative that record levels do not saturate the PCM A/D. Unlike analog audio, there is no grey area where a portion of the signal may be allowed to extend past the dynamic ceiling. If the peak level meters, used on the PCM-100 processor, indicate overlevel than that material is distorted beyond the use of this facility. With this in mind, the digital master series has reference tones that allow speech signals to be recorded at a universal level, making full use of the A/D - D/A range and also to be played back at levels acceptable for processor input or analog dubbing.

The 9dBm EPL figure is used as the universal digital master presentation level. Speech peaks will often approach, but rarely exceed, 5dB above 0Vu (0Vu = +4dBm). This allows 10dB of headroom on the PCM-100. A 5KHz reference tone is recorded on the masters and reads 0Vu on the PCM-100 (-15dbVu from saturation). See Fig 8.2.

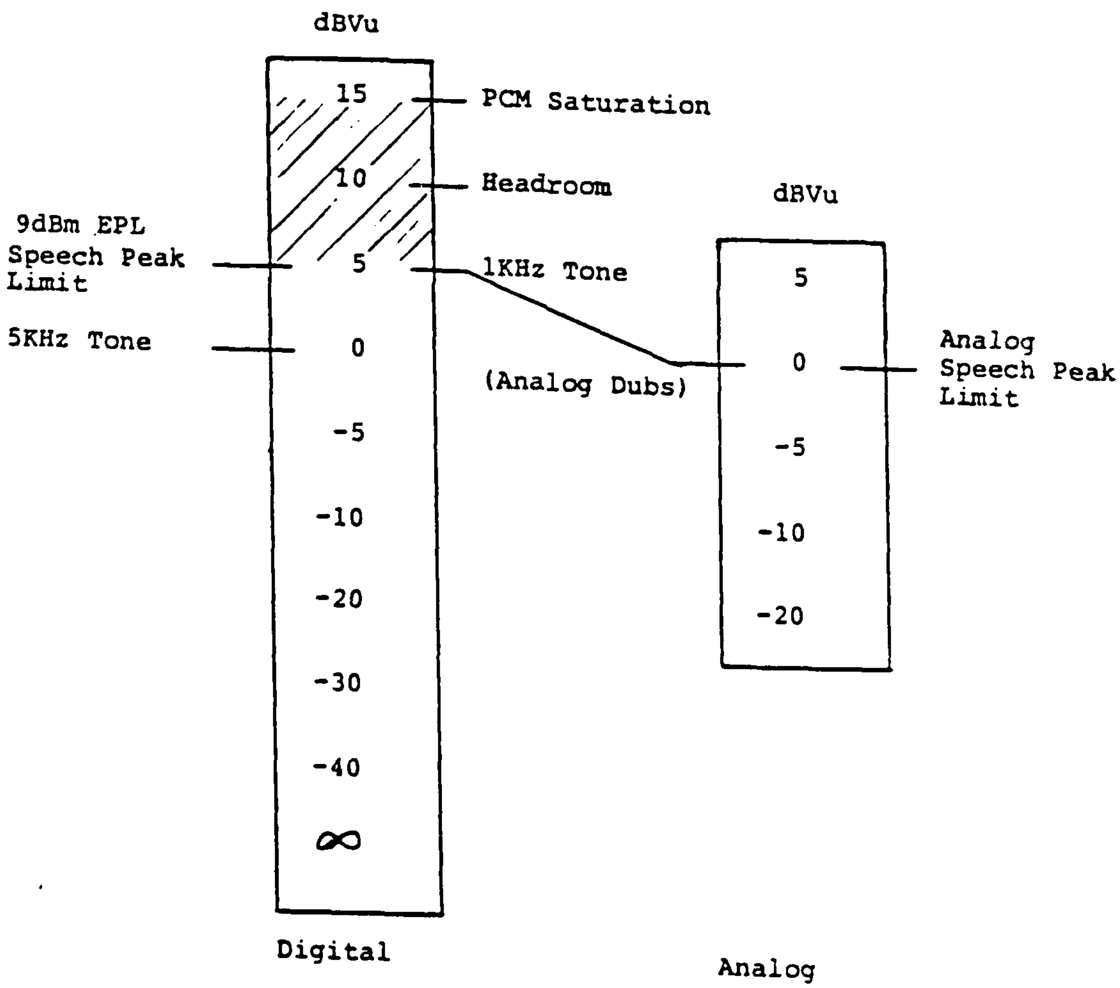

Figure 8.2 Test Tone References

A second reference is a 1KHz tone that reads +5dBVu on the PCM-100 (-10dB Vu from saturation). This tone is used for generating analog dubs. To allow speech peaks to consistently reach levels of +5dB above 0Vu on a conventional analog recording deck invites too much of a chance to distort important speech information. Use of this 1KHz tone as a reference for a 0Vu input to an analog deck insures speech peaks approaching but rarely passing 0Vu.

Reference tones are recorded using an oscilloscope and an electronic counter to insure quality and consistency of the signal, the Microdot brand sine wave generator was used to produce two reference tones. These sine waves, 1KHz at 10db below PCM saturation and 5KHz at 0Vu, were recorded digitally in lengthy sections. When the masters are edited into their final formats, sections of these tones are digitally dubbed in providing consistent tones throughout the master series. These new tones were recorded to insure full quality, stable references.

8.3.7 Dubbing

Working copies residing on Beta videocassette will be copied using the PCM-F1. The video output of a U-matic deck is sent to the video input of the F1. The BETA video deck, model SL2000, will be plugged into the "copy out" port and the direct copy function of the PCM-F1 will be used. Begin recording on the Beta deck and start the U-matic deck. The F1 will produce a direct digital dub of the U-matic on Beta with the exact same levels and frequency response. The F1 will also provide an analog output for monitoring (*Fig. 8.3*).

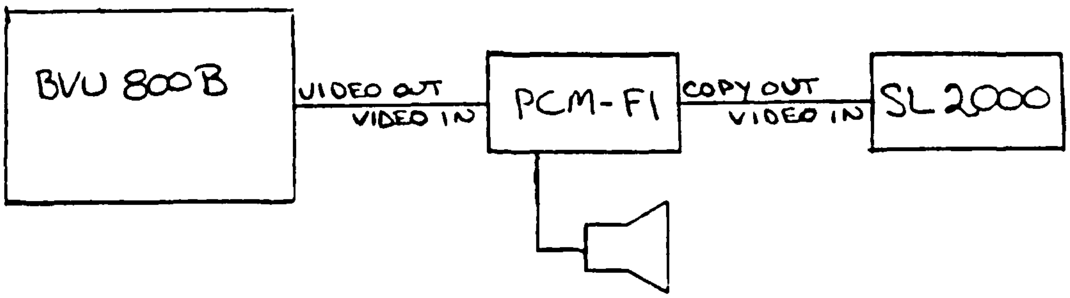

Figure 8.3 Digital Dubbing Configuration

Analog dubs are produced directly from the analog outputs of the PCM-100. The 5K Hz tone is not dubbed and the 1K Hz reference tone is set to 0Vu on the input side of the analog deck. This insures speech peaks approaching, but rarely surpassing 0Vu (+4dBm).

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14. Sony Corporation, "Digital Audio Editor DAE-1100 Operation and Maintenance Manual", 3rd edition, revised, pp.1-13.

15. Sony Corporation, "PCM-100 Operating Instructions", 1979.

16. G. White, Video Techniques, Butterworth and Co. Ltd., 1982, pp.17-23.

17. Sony Corporation, "BVU-800 Operation and Maintenance Manual", 6th edition, revised 3.

18. Sony Corporation, "PCM-F1 Operating Instructions", 1982, pg. 26.

NOTE: Although this report references the following limited documents, no limited information has been extracted.

Item 6. DOD and DOD contractors only; software documentation, Dec 85. Other requests RADC (EEV), Hanscom AFB MA 07131-5000.

Item 7. DOD and DOD contractors only; premature dissemination, Mar 85. Other requests RADC (EEV), Hanscom AFB MA 01731-5000.

APPENDIX A

DRT/DAM DIGITAL MASTER LIBRARY

ENVIRONMENT	SPEAKER SEX	# OF DRT SCRAMBLINGS
QUIET	9 M / 9 F	36 / 36
CH-47 HELICOPTER NOISE	3 M / 3 F	12 / 12
SHIPBOARD NOISE	3 M / 3 F	6 / 12
OFFICE NOISE	3 M / 3 F	6 / 12
E-3A AIRCRAFT NOISE	6 M / 3 F	96 / 24
DESTROYER NOISE	3 M / 3 F	12 / 12
HELICOPTER CARRIER NOISE	3 M / 3 F	12 / 12
P-3C AIRCRAFT NOISE	3 M / 3 F	12 / 12
JEEP NOISE	3 M / 3 F	12 / 12
TANK NOISE	3 M / 3 F	12 / 12
E-4B AIRCRAFT NOISE	6 M / 3 F	96 / 48
EC-135 AIRCRAFT NOISE	6 M / 3 F	48 / 24

RADC/EEV
TEST AND EVALUATION LABORATORY
DIGITAL AUDIO MASTER LIBRARY
EPL EQUALIZED DRT/DAM TESTS

TITLE	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR
** ENVIRONMENT: QUIET ENVIRONMENT																								
MICROPHONES, LEFT CHANNEL: ALTEC 659A DYNAMIC; RIGHT CHANNEL: T1 CARBON																								
* SPEAKER SEX: MALE																								
D-1-A	CH	4A1	45.5	38.6	RH	6A	40.8	41.8	JE	3A1	47.3	46.0	JE	306B	36.9	37.4	CH	308B	37.6	43.9	RH	310A	40.9	44.1
D-2-A	CH	4A1	45.8	38.8	RH	6A	40.8	41.8	JE	3A1	46.1	46.0	JE	305B	39.4	45.5	CH	307A	39.4	44.5	RH	310B	42.6	45.4
D-3-A	CH	4A1	45.8	38.6	RH	6A	40.8	41.8	JE	3A1	47.1	45.9	JE	306A	34.5	37.2	CH	308A	37.3	43.7	RH	311A	40.5	45.1
D-4-A	CH	4A1	46.0	39.1	RH	6A	40.9	42.0	JE	3A1	46.6	46.8	JE	305A	38.7	45.2	CH	307B	37.2	43.3	RH	311B	38.5	45.6
D-1-B	LL	1A	40.0	42.1	BV	2A1	41.0	45.0	PK	7A1	47.8	43.6	LL	302B	40.8	46.7	BV	303A	38.9	39.7	PK	309A	41.3	37.9
D-2-B	LL	1A	40.3	42.8	BV	2A1	41.3	45.8	PK	7A1	49.0	44.6	LL	302A	40.2	46.5	BV	303B	42.2	40.6	PK	312B	38.2	41.3
D-3-B	LL	1A	40.5	42.8	BV	2A1	41.3	46.0	PK	7A1	49.0	44.8	LL	301A	39.2	46.9	BV	304A	37.4	35.0	PK	312A	40.3	40.2
D-4-B	LL	1A	40.4	42.7	BV	2A1	37.7	46.1	PK	7A1	49.5	45.1	LL	301B	38.1	45.9	BV	304B	37.0	36.6	PK	309B	41.4	38.7
D-1-C	AS	2A2	44.9	45.2	DP	3A2	39.0	38.3	IP	1A2	44.2	46.6	AS	321A	39.7	42.9	DP	324A	42.8	47.1	IP	319A	37.6	42.7
D-2-C	AS	2A2	44.9	45.2	DP	3A2	39.2	37.7	IP	1A2	44.0	46.6	AS	321B	40.6	43.8	DP	324B	42.7	46.4	IP	319B	37.7	40.4
D-3-C	AS	2A2	44.4	44.7	DP	3A2	38.7	37.6	IP	1A2	43.9	46.1	AS	322A	42.2	42.9	DP	323A	38.9	43.5	IP	320A	37.0	40.9
D-4-C	AS	2A2	44.7	44.8	DP	3A2	38.8	38.1	IP	1A2	44.0	46.2	AS	322B	41.2	41.2	DP	323B	42.6	47.5	IP	320B	37.5	39.8
* SPEAKER SEX: FEMALE																								
D5-1.1-A	VW	6A2	43.9	43.9	KS	8A2	44.3	45.0	MP	8A1	40.3	43.5	VW	329A	45.5	45.4	KS	333B	42.9	42.8	MP	314B	38.7	38.0
D5-1.2-A	VW	6A2	43.9	44.3	KS	8A2	44.5	45.5	MP	8A1	40.3	43.6	VW	329B	42.6	42.4	KS	333A	43.1	44.3	MP	314A	36.5	39.1
D5-1.3-A	VW	6A2	44.4	45.3	KS	8A2	45.0	45.9	MP	8A1	40.6	43.6	VW	330A	41.8	45.1	KS	334B	42.3	45.7	MP	313B	32.3	38.2
D5-1.4-A	VW	6A2	44.0	45.1	KS	8A2	45.1	46.0	MP	8A1	40.8	43.5	VW	330B	41.3	43.3	KS	334A	40.8	45.0	MP	313A	35.2	39.4
D5-1.1-B	JS	5A1	43.8	43.1	LS	9A1	41.8	40.7	LV	4A2	46.5	41.8	JS	317A	41.4	46.0	LS	315B	31.9	42.5	LV	325A	34.4	44.3
D5-1.2-B	JS	5A1	44.0	42.8	LS	9A1	41.9	40.2	LV	4A2	46.1	41.9	JS	317B	41.5	41.5	LS	315B	33.0	41.9	LV	325B	38.2	44.4
D5-1.3-B	JS	5A1	44.0	42.7	LS	9A1	41.9	40.1	LV	4A2	46.4	41.8	JS	318A	41.1	47.1	LS	316B	39.9	43.3	LV	326A	37.9	42.8
D5-1.4-B	JS	5A1	43.9	42.8	LS	9A1	41.9	40.5	LV	4A2	46.5	41.6	JS	318B	42.2	48.5	LS	316A	39.1	43.5	LV	326B	37.6	44.4
D5-1.1-C	AN	7A2	44.6	42.5	KG	9A2	39.1	37.4	LW	5A2	41.2	39.2	AN	331A	42.6	45.9	KG	335B	33.8	39.9	LW	327B	42.8	45.9
D5-1.2-C	AN	7A2	44.0	42.6	KG	9A2	39.2	38.0	LW	5A2	41.3	39.2	AN	331B	37.8	42.8	KG	335A	34.2	38.2	LW	327A	43.2	47.2
D5-1.3-C	AN	7A2	44.7	42.6	KG	9A2	39.4	38.0	LW	5A2	41.5	39.2	AN	332A	38.3	45.7	KG	336B	37.1	36.0	LW	328B	37.2	41.3
D5-1.4-C	AN	7A2	44.1	42.4	KG	9A2	39.2	37.8	LW	5A2	41.4	39.1	AN	332B	39.9	46.0	KG	336A	35.9	37.7	LW	328A	41.0	43.9
** ENVIRONMENT: HELICOPTER NOISE																								
MICROPHONES, CHANNEL LEFT: ELECTRO-VOICE M-87 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
N-2-A	RH	6A	7.9	5.0	JE	3A	5.0	5.0	CH	4A	5.2	5.0	RH	317A	5.4	5.0	JE	309A	7.7	5.0	CH	313B	7.9	5.0
N-2-B	RH	6A	7.8	5.0	JE	3A	5.0	5.0	CH	4A	5.2	5.0	RH	317B	5.0	5.0	JE	309B	5.3	5.0	CH	313A	5.0	5.0
* SPEAKER SEX: FEMALE																								
N2-1.1-C	VW	6A2	10.4	9.0	KS	8A2	9.1	5.0	MP	8A	7.1	5.0	VW	303A	11.7	12.7	KS	305A	7.2	5.0	MP	307A	7.5	5.0
N2-1.2-C	VW	6A2	10.7	8.9	KS	8A2	8.4	5.0	MP	8A	5.0	5.0	VW	303B	11.1	10.3	KS	305B	8.4	5.0	MP	307B	5.0	5.0

TITLE	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR
** ENVIRONMENT: HELICOPTER NOISE MICROPHONES, CHANNEL LEFT: ELECTRO-VOICE EV985 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
N2-2.1-A	RH	6A	8.4	5.0	JE	3A	11.7	5.0	CH	4A	8.7	5.0	RH	306A	5.0	5.0	JE	310B	12.7	5.0	CH	322A	7.4	5.0
N2-2.2-A	RH	6A	8.0	5.0	JE	3A	11.6	5.0	CH	4A	8.7	5.0	RH	306B	6.2	5.0	JE	310A	12.5	5.0	CH	322B	7.4	5.0
* SPEAKER SEX: FEMALE																								
N2-2.1-C	VW	6A2	11.6	5.0	KS	8A2	9.4	5.0	MP	8A	5.2	5.0	VW	304A	13.8	5.0	KS	306B	8.0	5.0	MP	308A	6.2	5.0
N2-2.2-C	VW	6A2	11.6	5.0	KS	8A2	9.3	5.0	MP	8A	5.2	5.0	VW	304B	13.9	5.0	KS	306A	7.3	5.0	MP	308B	5.1	5.0
** ENVIRONMENT: SHIPBOARD NOISE MICROPHONES, CHANNEL LEFT: ROANWELL CONFIDENCER CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
N-3-A	RH	6A	39.8	9.3	JE	3A	37.1	11.9	CH	4A	34.3	12.7	RH	303A	41.4	16.8	JE	311A	36.9	7.7	CH	315A	35.8	18.0
N-3-B	RH	6A	39.9	9.4	JE	3A	37.2	11.9	CH	4A	34.4	12.7	RH	303B	42.7	18.8	JE	311B	37.9	7.3	CH	315B	36.0	17.7
* SPEAKER SEX: FEMALE																								
N3-1.1-C	VW	6A2	18.1	9.6	KS	8A2	17.7	5.9	MP	8A	16.2	14.2	VW	305A	20.5	15.5	KS	307A	17.8	9.9	MP	309B	22.6	15.3
N3-1.2-C	VW	6A2	18.3	9.6	KS	8A2	7.8	18.0	MP	8A	16.6	14.1	VW	305B	18.1	11.5	KS	307B	18.2	11.0	MP	309A	21.5	10.2
N3-1.3-C	VW	6A2	18.2	9.8	KS	8A2	7.8	17.7	MP	8A	16.4	14.2	VW	306A	20.3	13.5	KS	308A	15.8	9.0	MP	310B	20.2	16.6
N3-1.4-C	VW	6A2	18.1	9.7	KS	8A2	17.9	6.2	MP	8A	16.8	14.2	VW	306B	20.9	14.8	KS	308B	16.5	7.8	MP	310A	23.6	14.3
** ENVIRONMENT: OFFICE NOISE MICROPHONES, CHANNEL LEFT: ALTEC 659A DYNAMIC CHANNEL RIGHT: ROANWELL CONFIDENCER																								
* SPEAKER SEX: MALE																								
N-4-A	RH	6A	23.1	40.6	JE	3A	30.4	38.9	CH	4A	27.1	40.5	RH	304A	24.2	40.1	JE	312A	32.4	38.3	CH	316A	26.2	39.9
N-4-B	RH	6A	23.0	40.8	JE	3A	30.4	38.8	CH	4A	27.0	40.8	RH	304B	20.5	41.4	JE	312B	31.9	35.4	CH	316B	23.8	38.2
* SPEAKER SEX: FEMALE																								
N4-1.1-C	VW	6A2	26.3	30.4	KS	8A2	33.0	23.3	MP	8A	30.3	28.9	VW	307A	35.5	39.9	KS	310B	32.7	26.2	MP	312A	31.8	26.1
N4-1.2-C	VW	6A2	26.8	30.4	KS	8A2	32.9	23.3	MP	8A	30.3	28.8	VW	307B	32.4	36.0	KS	310A	34.4	27.2	MP	312B	27.5	31.0
N4-1.3-C	VW	6A2	26.8	30.3	KS	8A2	33.1	23.2	MP	8A	30.4	28.7	VW	308A	30.8	37.0	KS	309B	32.5	27.0	MP	311A	32.2	32.9
N4-1.4-C	VW	6A2	26.9	30.4	KS	8A2	33.1	23.3	MP	8A	30.4	28.9	VW	308B	34.7	35.3	KS	309A	31.8	32.9	MP	311B	33.0	31.2
** ENVIRONMENT: E-3A AIRCRAFT NOISE, CONSOLE 04 WITH PUFFSCREEN MICROPHONES, CHANNEL LEFT: ROANWELL 215-330-001 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J1-1.1-A	RH	6A	20.0	9.6	JE	3A	24.6	11.9	CH	4A	25.8	9.7	RH	326B	15.6	5.0	JE	314B	24.1	8.9	CH	324A	25.9	6.0
J1-1.2-A	RH	6A	19.9	9.7	JE	3A	24.6	12.2	CH	4A	25.9	9.7	RH	326A	15.7	5.6	JE	314A	24.0	10.9	CH	324B	27.7	10.7
J1-1.1-B	AS	2A2	23.9	12.1	DP	3A2	23.8	11.2	BV	2A	21.9	7.0	AS	316A	22.2	8.5	DP	306A	26.1	12.8	BV	302A	25.0	9.9
J1-1.2-B	AS	2A2	23.8	12.1	DP	3A2	23.8	11.6	BV	2A	21.9	6.8	AS	316B	21.1	9.7	DP	306B	26.0	13.2	BV	302B	21.4	8.6
* SPEAKER SEX: FEMALE																								
J1-1.1-C	VW	6A2	27.2	13.2	KS	8A2	21.9	5.5	MP	8A	22.3	12.4	VW	310A	29.0	15.2	KS	312B	20.7	5.0	MP	328A	24.5	14.0
J1-1.2-C	VW	6A2	27.3	13.1	KS	8A2	21.7	5.7	MP	8A	22.3	12.6	VW	310B	29.4	17.2	KS	312A	22.6	6.0	MP	328B	24.8	15.1

TITLE	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR
** ENVIRONMENT: E-3A AIRCRAFT NOISE, CONSOLE 04 WITHOUT PUFFSCREEN MICROPHONES, CHANNEL LEFT: ROANWELL 215-330-001 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J1-2.1-A	RH	6A	16.9	6.3	JE	3A	24.1	13.0	CH	4A	23.2	6.3	RH	325B	14.1	5.0	JE	313A	23.2	9.6	CH	323A	25.5	5.8
J1-2.2-A	RH	6A	16.9	6.3	JE	3A	24.1	13.0	CH	4A	23.1	6.5	RH	325A	15.5	5.2	JE	313B	22.3	9.7	CH	323B	26.0	7.8
J1-2.1-B	AS	2A2	22.8	13.4	DP	3A2	24.9	8.8	BV	2A	28.0	6.9	AS	315A	23.1	10.9	DP	305B	26.4	8.2	BV	301A	29.8	10.9
J1-2.2-B	AS	2A2	22.8	13.4	DP	3A2	24.9	8.8	BV	2A	28.0	6.9	AS	315B	24.0	11.8	DP	305B	26.4	8.2	BV	301B	31.0	10.6
* SPEAKER SEX: FEMALE																								
J1-2.1-C	VW	6A2	24.9	11.0	KS	8A2	25.6	12.3	MP	8A	25.0	11.5	VW	309A	32.3	16.6	KS	311A	28.2	14.2	MP	327B	26.7	10.4
J1-2.2-C	VW	6A2	24.8	11.0	KS	8A2	25.6	12.2	MP	8A	25.0	11.4	VW	309B	31.2	17.3	KS	311B	27.2	11.1	MP	327A	28.6	15.2
** ENVIRONMENT: E-3A AIRCRAFT NOISE, CONSOLE 10 WITH PUFFSCREEN MICROPHONES, CHANNEL LEFT: ROANWELL 215-330-001 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J2-1.1-A	RH	6A	19.4	13.7	JE	3A	22.8	9.3	CH	4A	22.7	9.2	RH	328B	16.0	10.2	JE	330A	20.8	8.0	CH	326A	21.9	9.0
J2-1.2-A	RH	6A	19.4	13.6	JE	3A	22.8	9.5	CH	4A	22.7	9.3	RH	328A	17.1	7.6	JE	330B	20.1	7.1	CH	326B	21.2	8.1
J2-1.1-B	AS	2A2	19.0	6.5	DP	3A2	28.4	13.0	BV	2A	21.1	5.0	AS	318A	18.2	5.0	DP	308A	28.7	13.3	BV	304A	24.8	5.5
J2-1.2-B	AS	2A2	19.0	6.3	DP	3A2	28.3	13.1	BV	2A	21.1	5.0	AS	318B	15.8	5.0	DP	308B	27.9	12.4	BV	304B	23.2	5.0
* SPEAKER SEX: FEMALE																								
J2-1.1-C	VW	6A2	28.2	15.6	KS	8A2	19.6	9.0	MP	8A	23.7	13.4	VW	312A	28.2	13.9	KS	314A	18.4	7.8	MP	316A	24.2	14.4
J2-1.2-C	VW	6A2	28.3	15.6	KS	8A2	19.7	9.1	MP	8A	23.8	13.4	VW	312B	29.6	15.9	KS	314B	18.9	7.0	MP	316B	26.0	15.6
** ENVIRONMENT: E-3A AIRCRAFT NOISE, CONSOLE 10 WITHOUT PUFFSCREEN MICROPHONES, CHANNEL LEFT: ROANWELL 215-330-001 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J2-2.1-A	RH	6A	22.6	15.4	JE	3A	25.9	10.5	CH	4A	21.4	8.4	RH	327A	18.0	9.3	JE	329A	23.7	7.9	CH	325A	21.1	6.5
J2-2.2-A	RH	6A	22.6	15.3	JE	3A	25.9	10.4	CH	4A	21.5	7.9	RH	327B	19.0	10.4	JE	329B	24.8	8.8	CH	325B	20.8	6.6
J2-2.1-B	AS	2A2	18.9	5.0	DP	3A2	25.0	10.7	BV	2A	20.5	8.0	AS	317A	21.1	5.0	DP	307A	24.9	8.0	BV	303A	23.4	9.9
J2-2.2-B	AS	2A2	19.1	5.0	DP	3A2	25.1	10.7	BV	2A	20.5	8.0	AS	317B	19.9	5.0	DP	307B	24.3	10.8	BV	303B	21.6	10.2
* SPEAKER SEX: FEMALE																								
J2-2.1-C	VW	6A2	22.4	11.9	KS	8A2	24.5	11.0	MP	8A	22.0	12.6	VW	311A	29.0	17.4	KS	313A	24.6	12.3	MP	315A	25.8	15.6
J2-2.2-C	VW	6A2	22.3	11.9	KS	8A2	24.3	11.2	MP	8A	21.9	12.8	VW	311B	28.7	15.8	KS	313B	32.1	11.0	MP	315B	24.4	14.0
** ENVIRONMENT: E-3A AIRCRAFT NOISE, CONSOLE 30 WITH PUFFSCREEN MICROPHONES, CHANNEL LEFT: ROANWELL 215-330-001 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J3-1.1-A	RH	6A	25.2	16.2	JE	3A	26.2	11.0	CH	4A	18.3	7.3	RH	316B	23.2	13.5	JE	308B	25.2	7.3	CH	318A	20.7	6.3
J3-1.2-A	RH	6A	25.2	16.2	JE	3A	26.2	11.1	CH	4A	18.3	7.3	RH	316A	23.8	14.3	JE	308A	25.9	9.1	CH	318B	16.2	7.6
J3-1.1-B	AS	2A2	23.9	11.1	DP	3A2	25.5	18.2	BV	2A	25.3	7.2	AS	320A	25.6	8.7	DP	326B	25.4	16.4	BV	322A	25.4	5.6
J3-1.2-B	AS	2A2	23.9	11.1	DP	3A2	25.4	18.2	BV	2A	25.4	7.2	AS	320B	24.6	7.7	DP	326A	26.4	17.2	BV	322B	24.9	6.3

TITLE	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR
** ENVIRONMENT: E-3A AIRCRAFT NOISE, CONSOLE 30 WITHOUT PUFFSCREEN MICROPHONES, CHANNEL LEFT: ROANWELL 215-330-001 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J3-2.1-A	RH	6A	23.4	17.0	JE	3A	27.2	12.8	CH	4A	18.9	5.4	RH	315A	20.1	13.3	JE	307A	27.1	11.4	CH	317A	20.9	5.4
J3-2.2-A	RH	6A	23.4	17.0	JE	3A	27.3	12.9	CH	4A	19.0	5.5	RH	315B	21.9	14.5	JE	307B	26.1	10.7	CH	317B	21.6	6.2
J3-2.1-B	AS	2A2	21.0	8.2	DP	3A2	22.7	14.6	BV	2A	26.3	8.3	AS	319A	22.2	6.2	DP	325B	23.5	15.2	BV	321B	24.4	5.7
J3-2.2-B	AS	2A2	21.0	8.0	DP	3A2	22.6	14.7	BV	2A	26.3	8.1	AS	319B	21.7	5.5	DP	325A	23.2	15.1	BV	321A	26.8	5.9
** ENVIRONMENT: QUIET, E-3A HEADSET WITH PUFFSCREEN MICROPHONES, CHANNEL LEFT: ROANWELL 215-330-001 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J4-1.1-A	RH	6A	44.2	42.7	JE	3A	44.0	40.4	CH	4A	41.4	40.5	RH	304B	41.3	41.7	JE	306A	45.6	39.0	CH	320A	44.0	41.1
J4-1.2-A	RH	6A	44.6	42.8	JE	3A	43.9	40.3	CH	4A	42.9	40.7	RH	304A	38.6	41.4	JE	306B	43.1	40.1	CH	320B	42.9	40.0
J4-1.1-B	AS	2A2	44.0	38.4	DP	3A2	44.9	40.4	BV	2A	42.0	38.3	AS	314A	45.8	40.7	DP	328B	44.2	43.6	BV	324B	44.4	38.0
J4-1.2-B	AS	2A2	44.3	38.6	DP	3A2	44.9	40.3	BV	2A	41.8	38.4	AS	314B	45.5	41.6	DP	328A	42.2	42.5	BV	324A	37.3	39.0
** ENVIRONMENT: QUIET, E-3A HEADSET WITHOUT PUFFSCREEN MICROPHONES, CHANNEL RIGHT: ROANWELL 215-330-001 CHANNEL LEFT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J4-2.1-A	RH	6A	44.5	43.9	JE	3A	46.5	42.1	CH	4A	46.5	42.5	RH	303A	42.7	42.2	JE	305A	46.5	40.4	CH	319A	45.2	39.2
J4-2.2-A	RH	6A	43.9	43.8	JE	3A	46.3	42.1	CH	4A	46.4	42.6	RH	303B	42.1	42.1	JE	305B	46.8	40.2	CH	319B	45.5	40.3
J4-2.1-B	AS	2A2	45.4	37.5	DP	3A2	47.6	40.5	BV	2A	46.4	31.4	AS	313A	45.7	38.2	DP	327A	46.9	42.7	BV	323A	45.8	39.7
J4-2.2-B	AS	2A2	44.9	37.5	DP	3A2	48.1	40.5	BV	2A	46.9	32.1	AS	313B	45.6	38.0	DP	327B	46.6	42.5	BV	323B	46.0	35.7
** ENVIRONMENT: DESTROYER NOISE MICROPHONES, CHANNEL LEFT: ELECTRO-VOICE H250 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J5-1.1-A	RH	6A	10.3	25.9	JE	3A	10.3	17.8	CH	4A	10.4	21.1	RH	329A	11.6	24.4	JE	331A	9.7	16.6	CH	327B	12.3	19.8
J5-1.2-A	RH	6A	10.4	25.9	JE	3A	10.3	17.7	CH	4A	10.5	21.2	RH	329B	12.1	25.4	JE	331B	7.6	15.6	CH	327A	18.1	18.2
* SPEAKER SEX: FEMALE																								
J5-1.1-C	VW	6A2	12.7	22.5	KS	8A2	7.1	21.4	MP	8A	14.0	27.0	VW	313A	14.2	22.7	KS	315A	5.3	15.3	MP	317A	16.2	29.3
J5-1.2-C	VW	6A2	12.4	22.2	KS	8A2	6.8	21.4	MP	8A	13.9	24.1	VW	313B	14.9	25.2	KS	315B	5.7	17.1	MP	317B	15.7	28.7
** ENVIRONMENT: DESTROYER NOISE MICROPHONES, CHANNEL LEFT: TA840 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J5-2.1-A	RH	6A	21.8	21.9	JE	3A	17.6	22.5	CH	4A	5.7	16.3	RH	330A	20.1	20.1	JE	323B	17.0	21.1	CH	328B	7.3	17.6
J5-2.2-A	RH	6A	21.9	21.9	JE	3A	17.2	22.5	CH	4A	5.8	16.3	RH	330B	20.7	19.8	JE	332A	20.1	24.7	CH	328A	7.2	15.2
* SPEAKER SEX: FEMALE																								
J5-2.1-C	VW	6A2	16.1	16.4	KS	8A2	14.5	14.6	MP	8A	19.2	22.7	VW	314A	14.1	17.7	KS	316A	13.6	12.4	MP	318A	18.3	23.3
J5-2.2-C	VW	6A2	16.2	16.4	KS	8A2	14.7	14.8	MP	8A	19.3	22.7	VW	314B	17.6	18.6	KS	316B	12.5	12.5	MP	318B	18.4	23.6

TITLE	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR
** ENVIRONMENT: HELICOPTER CARRIER NOISE																								
MICROPHONES, CHANNEL LEFT: ELECTRO-VOICE H250 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J6-1.1-A	RH	6A	25.0	28.4	JE	3A	24.4	25.1	CH	4A	20.8	16.0	RH	331A	32.2	28.5	JE	333B	21.3	20.5	CH	329A	21.9	15.9
J6-1.2-A	RH	6A	24.1	28.4	JE	3A	24.4	25.1	CH	4A	20.9	15.9	RH	331B	31.5	27.3	JE	333A	20.6	21.6	CH	329B	21.9	16.3
* SPEAKER SEX: FEMALE																								
J6-1.1-C	VW	6A2	26.9	20.2	KS	8A2	19.1	22.1	MP	8A	25.5	31.8	VW	315A	28.8	23.0	KS	317A	20.7	21.0	MP	319B	28.1	28.1
J6-1.2-C	VW	6A2	27.0	20.1	KS	8A2	19.0	22.1	MP	8A	25.5	31.8	VW	315B	25.4	22.7	KS	317B	19.2	20.2	MP	319A	28.4	26.9
** ENVIRONMENT: HELICOPTER CARRIER NOISE																								
MICROPHONES, CHANNEL RIGHT: TA840 CHANNEL LEFT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J6-2.1-A	RH	6A	29.9	22.7	JE	3A	22.9	23.2	CH	4A	11.6	15.3	RH	332A	31.5	22.4	JE	334A	21.4	23.1	CH	330B	13.7	16.5
J6-2.2-A	RH	6A	30.0	22.6	JE	3A	22.9	23.1	CH	4A	12.1	15.2	RH	332B	30.9	23.2	JE	334B	23.8	22.1	CH	330A	13.7	15.1
* SPEAKER SEX: FEMALE																								
J6-2.1-C	VW	6A2	26.6	20.6	KS	8A2	24.9	21.8	MP	8A	29.0	28.3	VW	316A	28.9	24.5	KS	318A	27.3	18.6	MP	320B	29.3	25.8
J6-2.2-C	VW	6A2	26.6	20.5	KS	8A2	25.3	21.7	MP	8A	27.5	28.1	VW	316B	28.7	22.8	KS	318B	27.4	19.7	MP	320A	28.2	27.7
** ENVIRONMENT: P-3C AIRCRAFT NOISE																								
MICROPHONES, CHANNEL LEFT: ELECTRO-VOICE EV985 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J7-1.1-A	RH	6A	19.2	5.0	JE	3A	24.9	5.0	CH	4A	22.9	5.0	RH	333A	18.0	5.0	JE	335A	26.7	5.0	CH	331A	23.6	5.0
J7-1.2-A	RH	6A	19.1	5.0	JE	3A	24.9	5.0	CH	4A	22.8	5.0	RH	333B	18.5	5.0	JE	335B	27.1	5.0	CH	331B	24.2	5.0
* SPEAKER SEX: FEMALE																								
J7-1.1-C	VW	6A2	16.7	5.0	KS	8A2	20.2	5.0	MP	8A	20.8	5.0	VW	317A	19.6	5.0	KS	319A	19.8	5.0	MP	321B	22.4	5.0
J7-1.2-C	VW	6A2	17.0	5.0	KS	8A2	20.4	5.0	MP	8A	21.0	5.0	VW	317B	19.7	5.0	KS	319B	20.8	5.0	MP	321A	24.6	5.0
** ENVIRONMENT: P-3C AIRCRAFT NOISE																								
MICROPHONES, CHANNEL LEFT: M-92 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J7-2.1-A	RH	6A	18.4	5.0	JE	3A	18.1	6.8	CH	4A	13.9	5.0	RH	333A	18.5	5.0	JE	336B	20.3	5.0	CH	332A	15.8	5.0
J7-2.2-A	RH	6A	18.4	5.0	JE	3A	18.0	6.7	CH	4A	13.9	5.0	RH	333B	18.7	5.0	JE	336A	21.5	5.0	CH	332B	12.7	5.0
* SPEAKER SEX: FEMALE																								
J7-2.1-C	VW	6A2	9.9	5.0	KS	8A2	13.8	5.0	MP	8A	12.7	7.3	VW	318A	18.0	2.9	KS	320A	17.9	5.0	MP	322A	15.7	10.3
J7-2.2-C	VW	6A2	9.9	5.0	KS	8A2	13.8	5.0	MP	8A	12.6	7.2	VW	318B	17.0	5.0	KS	320B	17.3	5.0	MP	322B	15.1	9.8
** ENVIRONMENT: JEEP NOISE																								
MICROPHONES, CHANNEL LEFT: ELECTRO-VOICE H250 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J8-1.1-A	RH	6A	27.1	14.3	JE	3A	22.0	9.2	CH	4A	18.4	7.9	RH	335A	25.0	13.4	JE	301B	19.1	7.4	CH	334B	18.9	8.5
J8-1.2-A	RH	6A	27.1	14.0	JE	3A	22.0	9.1	CH	4A	18.4	7.7	RH	335B	26.4	12.6	JE	301A	18.5	6.4	CH	334A	20.0	8.6
J8-1.3-A	RH	6A	27.1	14.1	JE	3A	22.1	9.2	CH	4A	18.4	7.8	RH	336A	26.1	14.8	JE	302B	19.8	9.1	CH	333B	20.3	9.8
J8-1.4-A	RH	6A	27.1	14.2	JE	3A	22.1	9.1	CH	4A	18.4	7.9	RH	336B	24.7	13.1	JE	302A	18.8	10.6	CH	333A	19.9	9.0

TITLE	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR	SKR	DRT LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR
* SPEAKER SEX: FEMALE																								
J8-1.1-C	VW	6A2	21.5	16.7	KS	8A2	20.1	12.1	MP	8A	21.2	7.5	VW	319A	23.4	16.7	KS	322A	19.9	11.3	MP	324B	23.3	7.1
J8-1.2-C	VW	6A2	21.5	16.5	KS	8A2	20.1	12.0	MP	8A	21.1	7.3	VW	319B	22.4	15.2	KS	322B	18.5	9.6	MP	324A	22.7	8.7
J8-1.3-C	VW	6A2	21.6	16.7	KS	8A2	20.2	12.1	MP	8A	21.2	7.4	VW	320A	21.4	17.1	KS	321A	18.9	11.8	MP	323B	23.3	6.0
J8-1.4-C	VW	6A2	21.7	16.8	KS	8A2	20.1	11.9	MP	8A	21.2	7.5	VW	320B	22.7	15.9	KS	321B	19.3	12.1	MP	323A	22.3	5.4
** ENVIRONMENT: TANK NOISE MICROPHONES, CHANNEL LEFT: ELECTRO-VOICE LV985 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J9-1.1-A	RH	6A	22.3	5.0	JE	3A	24.0	6.7	CH	4A	19.9	5.0	RH	301A	20.9	5.0	JE	303A	24.4	5.0	CH	335A	18.7	5.0
J9-1.2-A	RH	6A	22.4	5.0	JE	3A	24.3	5.0	CH	4A	19.9	5.0	RH	301B	20.2	5.0	JE	303B	24.0	5.0	CH	335B	18.2	5.0
* SPEAKER SEX: FEMALE																								
J9-1.1-C	VW	6A2	13.7	5.0	KS	8A2	18.4	5.0	MP	8A	21.8	5.0	VW	325A	20.7	5.0	KS	323A	17.5	5.0	MP	331A	24.4	6.0
J9-1.2-C	VW	6A2	13.8	5.0	KS	8A2	18.4	5.0	MP	8A	22.1	5.0	VW	325B	17.2	5.0	KS	323B	16.1	5.0	MP	331B	23.1	5.0
** ENVIRONMENT: TANK NOISE MICROPHONES, CHANNEL LEFT: ELECTRO-VOICE M-87 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J9-2.1-A	RH	6A	16.2	5.0	JE	3A	23.0	5.0	CH	4A	17.7	5.0	RH	302A	16.0	5.0	JE	304B	20.7	5.0	CH	336B	16.3	5.0
J9-2.2-A	RH	6A	16.2	5.0	JE	3A	23.0	5.0	CH	4A	17.7	5.0	RH	302B	16.9	5.0	JE	304A	22.1	5.0	CH	336A	16.8	5.0
* SPEAKER SEX: FEMALE																								
J9-2.1-C	VW	6A2	19.4	5.0	KS	8A2	18.1	5.0	MP	8A	23.0	5.0	VW	322A	20.4	5.0	KS	324B	17.5	5.0	MP	326A	24.7	6.1
J9-2.2-C	VW	6A2	19.7	5.0	KS	8A2	18.2	5.0	MP	8A	23.0	5.1	VW	322B	19.5	5.0	KS	324A	17.2	5.0	MP	326B	24.5	7.0
** ENVIRONMENT: E4B AIRCRAFT NOISE, BATTLESTAFF COMPARTMENT MICROPHONES, CHANNEL LEFT: ROANWELL 240100001 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J10-1.1-A	RH	6A	24.0	14.1	JE	3A	15.7	9.5	CH	4A	18.0	11.2	RH	323A	23.6	13.5	JE	314B	15.2	6.9	CH	309B	15.2	8.5
J10-1.2-A	RH	6A	23.9	13.9	JE	3A	15.6	9.4	CH	4A	18.0	11.0	RH	323B	22.1	12.1	JE	315A	12.9	5.2	CH	309A	16.5	9.1
J10-1.3-A	RH	6A	24.0	14.1	JE	3A	15.6	9.5	CH	4A	18.0	11.1	RH	324A	23.5	11.8	JE	315B	11.2	7.9	CH	310A	15.8	11.0
J10-1.4-A	RH	6A	24.0	14.1	JE	3A	15.7	9.6	CH	4A	18.1	11.2	RH	324B	24.5	12.9	JE	314A	10.6	6.8	CH	310B	15.2	8.1
J10-1.1-B	CT	5A	16.4	5.0	AS	1A2	23.9	11.9	BV	2A	21.8	8.2	CT	301B	17.5	5.6	AS	306B	19.4	10.8	BV	303A	24.7	8.9
J10-1.2-B	CT	5A	16.4	5.0	AS	1A2	23.9	12.3	BV	2A	21.8	8.2	CT	301A	21.4	5.1	AS	305A	22.4	10.1	BV	304B	25.8	7.5
J10-1.3-B	CT	5A	16.4	5.0	AS	1A2	23.9	12.2	BV	2A	21.8	8.1	CT	302A	17.3	5.0	AS	306A	20.8	8.2	BV	303B	22.4	11.4
J10-1.4-B	CT	5A	16.4	5.0	AS	1A2	23.9	12.2	BV	2A	21.8	7.8	CT	302B	16.3	5.0	AS	305B	21.2	12.7	BV	304A	23.4	8.2
* SPEAKER SEX: FEMALE																								
J10-1.1-C	VW	6A2	18.7	8.9	KS	8A2	11.1	6.7	MP	8A	18.8	8.4	VW	335A	22.2	17.6	KS	315B	15.7	5.0	MP	331A	20.7	8.1
J10-1.2-C	VW	6A2	18.6	8.7	KS	8A2	11.1	6.5	MP	8A	18.6	8.3	VW	335B	18.9	11.0	KS	316B	17.6	6.2	MP	332A	19.3	8.8
J10-1.3-C	VW	6A2	18.6	8.8	KS	8A2	11.1	6.7	MP	8A	18.6	8.3	VW	336A	21.7	14.2	KS	316A	19.2	5.0	MP	332B	21.3	8.3
J10-1.4-C	VW	6A2	18.7	8.9	KS	8A2	11.1	6.7	MP	8A	18.7	8.3	VW	336B	21.2	14.5	KS	315A	17.0	5.0	MP	331B	20.4	9.1

TITLE	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR	SKR	DRT LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR
** ENVIRONMENT: E4B AIRCRAFT NOISE, NCA COMPARTMENT MICROPHONES, CHANNEL LEFT: ROANWELL 240100001 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J10-2 1-A	RH	6A	34.4	23.2	JE	3A	22.2	17.0	CH	4A	25.2	17.1	RH	325A	35.6	22.4	JE	312A	20.6	15.3	CH	308A	22.8	15.4
J10-2 2-A	RH	6A	34.4	23.3	JE	3A	22.2	17.1	CH	4A	25.2	17.1	RH	326A	33.0	20.3	JE	312B	17.9	14.3	CH	308B	22.3	14.3
J10-2 3-A	RH	6A	34.4	23.3	JE	3A	22.2	17.1	CH	4A	25.2	17.1	RH	326B	33.6	20.6	JE	313B	16.7	13.8	CH	307B	23.5	16.3
J10-2 4-A	RH	6A	34.3	23.2	JE	3A	22.2	16.8	CH	4A	25.2	16.9	RH	325B	34.2	20.2	JE	313A	17.5	12.6	CH	307A	21.9	15.9
J10-2 1-B	CT	5A	23.1	10.7	AS	1A2	25.8	18.4	BV	2A	32.5	16.5	CT	308B	24.1	9.6	AS	312A	26.6	19.0	BV	309A	27.2	12.2
J10-2 2-B	CT	5A	23.1	10.5	AS	1A2	25.8	18.4	BV	2A	31.8	16.5	CT	307B	23.5	10.7	AS	311A	29.5	19.2	BV	309B	31.3	11.6
J10-2 3-B	CT	5A	23.2	10.6	AS	1A2	25.8	18.4	BV	2A	31.5	16.5	CT	308A	20.7	10.1	AS	312B	28.5	19.1	BV	310A	33.1	12.9
J10-2 4-B	CT	5A	23.1	10.6	AS	1A2	25.8	18.3	BV	2A	32.5	14.8	CT	307A	23.1	13.5	AS	311B	28.4	21.1	BV	310B	30.6	14.4
* SPEAKER SEX: FEMALE																								
J10-2 1-C	VW	6A2	27.8	19.7	KS	8A2	24.1	17.4	MP	8A	26.7	20.5	VW	301A	28.7	21.4	KS	317B	23.6	15.4	MP	333A	30.6	21.2
J10-2 2-C	VW	6A2	27.8	19.9	KS	8A2	24.1	17.7	MP	8A	26.9	20.7	VW	302A	30.2	23.5	KS	318B	25.0	15.8	MP	334A	26.7	22.8
J10-2 3-C	VW	6A2	27.8	19.8	KS	8A2	24.1	17.5	MP	8A	26.9	20.6	VW	302B	29.6	22.2	KS	318A	27.1	17.0	MP	334B	28.9	21.3
J10-2 4-C	VW	6A2	27.8	19.9	KS	8A2	24.1	17.5	MP	8A	26.9	20.7	VW	301B	29.1	22.6	KS	317A	24.5	16.4	MP	333B	30.0	21.6
** ENVIRONMENT: E4B AIRCRAFT NOISE, BRIEFING ROOM MICROPHONES, CHANNEL LEFT: ROANWELL 240100001 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J10-3 1-A	RH	6A	30.1	21.7	JE	3A	20.9	13.2	CH	4A	21.9	10.8	RH	327B	31.8	18.1	JE	317A	18.2	13.6	CH	305A	20.4	10.8
J10-3 2-A	RH	6A	30.1	21.7	JE	3A	20.8	13.2	CH	4A	21.8	10.7	RH	328B	29.0	17.8	JE	318A	16.2	8.8	CH	305B	20.1	10.8
J10-3 3-A	RH	6A	30.2	21.7	JE	3A	20.9	13.2	CH	4A	21.8	10.6	RH	328A	29.9	19.0	JE	318B	16.7	8.3	CH	306B	18.4	10.9
J10-3 4-A	RH	6A	30.1	21.6	JE	3A	20.8	13.0	CH	4A	21.7	10.6	RH	327A	33.5	21.9	JE	317B	16.0	10.9	CH	306A	19.0	10.4
J10-3 1-B	CT	5A	21.2	7.7	AS	1A2	27.9	11.6	BV	2A	30.3	19.3	CT	313A	23.4	8.6	AS	329B	29.0	11.5	BV	315A	31.0	16.9
J10-3 2-B	CT	5A	21.2	7.7	AS	1A2	28.2	11.4	BV	2A	30.9	19.3	CT	313B	20.5	7.1	AS	330B	29.6	9.4	BV	315B	31.5	15.1
J10-3 3-B	CT	5A	21.2	7.7	AS	1A2	28.3	11.5	BV	2A	30.9	19.4	CT	314A	21.4	5.6	AS	330A	27.2	9.1	BV	316A	26.3	17.6
J10-3 4-B	CT	5A	21.2	8.1	AS	1A2	28.3	11.6	BV	2A	30.9	19.4	CT	314B	21.8	5.0	AS	329A	29.7	14.2	BV	316B	31.6	12.8
* SPEAKER SEX: FEMALE																								
J10-3 1-C	VW	6A2	21.7	8.4	KS	8A2	22.0	8.6	MP	8A	24.6	11.2	VW	311A	21.3	9.9	KS	324B	22.7	7.8	MP	326B	25.5	11.9
J10-3 2-C	VW	6A2	21.7	8.3	KS	8A2	22.1	8.8	MP	8A	24.7	11.4	VW	312A	20.8	10.5	KS	323B	22.7	5.8	MP	325A	25.6	9.6
J10-3 3-C	VW	6A2	21.8	8.4	KS	8A2	22.0	8.6	MP	8A	24.6	11.3	VW	311B	21.9	12.1	KS	324A	21.2	5.2	MP	325B	23.1	9.9
J10-3 4-C	VW	6A2	21.7	8.3	KS	8A2	22.0	8.6	MP	8A	24.6	11.3	VW	312B	21.5	9.8	KS	323A	22.1	6.0	MP	326A	24.1	8.9
** ENVIRONMENT: E4B AIRCRAFT NOISE, BATTLESTAFF COMPARTMENT WITH PUFFSCREEN MICROPHONES, CHANNEL LEFT: ROANWELL 240100001 CHANNEL RIGHT: ALTEC 659A DYNAMIC																								
* SPEAKER SEX: MALE																								
J10-4 1-A	RH	6A	26.4	20.0	JE	3A	19.4	6.7	CH	4A	17.8	6.6	RH	329A	25.1	19.3	JE	313B	17.6	7.8	CH	316B	15.4	5.0
J10-4 2-A	RH	6A	26.3	19.9	JE	3A	19.4	6.6	CH	4A	17.8	6.9	RH	330A	25.5	17.6	JE	314B	18.4	5.6	CH	315A	17.2	7.3
J10-4 3-A	RH	6A	26.3	19.9	JE	3A	19.4	6.6	CH	4A	17.8	6.9	RH	329B	25.0	18.2	JE	313A	18.9	7.6	CH	316A	16.0	5.0
J10-4 4-A	RH	6A	26.4	19.9	JE	3A	19.4	6.7	CH	4A	17.8	7.0	RH	330B	25.1	18.6	JE	314A	18.4	6.6	CH	315B	16.0	5.0

TITLE	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR	SKR	DRT LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR
J10-4 1-B	CT	5A	24.7	5.0	AS	1A2	23.0	8.6	BV	2A	24.3	6.2	CT	307A	23.4	7.7	AS	319A	23.5	8.6	BV	318B	23.3	7.3
J10-4 2-B	CT	5A	24.3	5.0	AS	1A2	23.1	23.0	BV	2A	24.3	6.3	CT	308A	25.6	5.0	AS	319B	23.3	10.6	BV	317B	23.6	10.0
J10-4 3-B	CT	5A	20.3	5.0	AS	1A2	23.1	8.6	BV	2A	24.3	6.4	CT	307B	25.6	6.3	AS	320A	22.0	10.4	BV	317A	24.7	10.7
J10-4 4-B	CT	5A	24.8	5.0	AS	1A2	23.1	8.6	BV	2A	24.4	6.3	CT	308B	25.2	5.0	AS	320B	22.1	8.9	BV	318A	23.9	8.3
* SPEAKER SEX FEMALE																								
J10-4 1-C	VW	6A2	20.0	5.0	KS	8A2	14.9	8.8	MP	8A	15.6	5.7	VW	309A	24.2	7.4	KS	321A	14.0	5.0	MP	327B	19.0	7.0
J10-4 2-C	VW	6A2	20.0	5.0	KS	8A2	15.0	8.9	MP	8A	15.5	5.7	VW	310A	22.2	5.6	KS	321B	14.2	5.0	MP	328A	18.5	6.2
J10-4 3-C	VW	6A2	20.0	5.0	KS	8A2	15.0	8.8	MP	8A	15.5	5.6	VW	309B	18.8	5.3	KS	322A	13.1	5.0	MP	327A	20.1	6.1
J10-4 4-C	VW	6A2	20.0	5.0	KS	8A2	15.0	8.8	MP	8A	15.6	5.7	VW	310B	21.6	5.0	KS	322B	14.1	5.0	MP	328B	16.3	5.0

** ENVIRONMENT EC135 AIRCRAFT NOISE, BATTLESTAFF COMPARTMENT
MICROPHONES, CHANNEL LEFT: ROANWELL 60150 CHANNEL RIGHT: ALTEC 659A DYNAMIC

TITLE	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR	SKR	DRT LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR
* SPEAKER SEX MALE																								
J11-1 1-A	RH	6A	25.6	16.4	JE	3A	13.4	12.4	CH	4A	17.1	8.7	RH	330A	24.7	16.0	JE	309B	6.7	5.4	CH	304A	14.4	7.5
J11-1 2-A	RH	6A	25.7	16.5	JE	3A	13.5	12.5	CH	4A	17.1	7.8	RH	329B	25.7	16.6	JE	309A	10.2	6.9	CH	303B	14.9	7.6
J11-1 3-A	RH	6A	25.6	16.6	JE	3A	13.4	12.2	CH	4A	17.1	8.3	RH	329A	24.9	19.6	JE	310A	7.5	6.4	CH	304B	15.4	7.5
J11-1 4-A	RH	6A	0.0	0.0	JE	3A	13.3	12.3	CH	4A	17.1	8.3	RH	330B	24.6	16.9	JE	310B	8.1	5.3	CH	303A	14.3	6.9
J11-1 1-B	CT	5A	20.9	8.7	AS	1A2	23.5	8.6	BV	2A	24.8	11.4	CT	317A	20.2	12.3	AS	321B	25.2	13.2	BV	323A	21.6	11.9
J11-1 2-B	CT	5A	20.8	8.5	AS	1A2	23.3	11.2	BV	2A	24.7	11.4	CT	317B	22.4	11.0	AS	322B	25.2	11.0	BV	324A	22.7	9.2
J11-1 3-B	CT	5A	20.8	8.4	AS	1A2	23.1	11.2	BV	2A	24.7	11.4	CT	318A	22.6	11.4	AS	322A	25.9	11.5	EV	324B	22.2	9.6
J11-1 4-B	CT	5A	21.0	8.4	AS	1A2	23.3	11.1	BV	2A	24.7	11.5	CT	318B	22.9	12.0	AS	321A	25.0	13.4	BV	323B	22.9	11.7
* SPEAKER SEX FEMALE																								
J11-1 1-C	VW	6A2	23.2	16.1	KS	8A2	12.1	5.8	MP	8A	22.8	13.9	VW	303A	22.4	13.5	KS	311B	15.1	7.8	MP	320A	23.1	13.7
J11-1 2-C	VW	6A2	23.1	16.0	KS	8A2	12.1	5.7	MP	8A	22.6	13.4	VW	303B	25.4	17.7	KS	312B	10.7	5.0	MP	319B	25.4	15.6
J11-1 3-C	VW	6A2	23.3	16.3	KS	8A2	12.3	6.1	MP	8A	22.9	13.4	VW	304B	23.1	18.2	KS	311A	17.2	7.6	MP	320B	23.1	13.8
J11-1 4-C	VW	6A2	23.2	16.1	KS	8A2	12.1	5.7	MP	8A	22.9	13.4	VW	304A	24.8	18.8	KS	312A	12.2	7.1	MP	319B	20.9	11.8

** ENVIRONMENT EC135 AIRCRAFT NOISE, RADIO COMPARTMENT
MICROPHONES, CHANNEL LEFT: ROANWELL 60150 CHANNEL RIGHT: ALTEC 659A DYNAMIC

TITLE	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DAM LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR	SKR	DRT LIST	S/N MICL	S/N MICR	SPKR	DRT LIST	S/N MICL	S/N MICR
* SPEAKER SEX MALE																								
J11-2 1-A	RH	6A	24.4	20.1	JE	3A	14.9	12.5	CH	4A	10.6	8.2	RH	331A	22.6	22.5	JE	307B	12.8	14.2	CH	301B	15.3	9.8
J11-2 2-A	RH	6A	24.4	20.1	JE	3A	14.8	12.2	CH	4A	13.5	7.9	RH	331B	23.1	21.8	JE	308B	13.9	10.2	CH	302B	13.3	6.6
J11-2 3-A	RH	6A	24.4	20.1	JE	3A	14.8	12.4	CH	4A	13.6	8.0	RH	332A	23.6	22.9	JE	308A	13.9	12.0	CH	301A	15.9	11.3
J11-2 4-A	RH	6A	24.4	20.1	JE	3A	14.9	12.4	CH	4A	13.5	8.0	RH	332B	23.8	20.6	JE	307A	13.0	13.8	CH	302A	16.1	9.7
J11-2 1-B	CT	5A	20.3	12.8	AS	1A2	21.8	14.6	BV	2A	17.8	8.7	CT	319A	16.7	11.1	AS	328B	23.5	13.7	EV	326A	20.0	9.9
J11-2 2-B	CT	5A	20.3	12.8	AS	1A2	21.7	14.5	BV	2A	17.8	8.6	CT	320B	20.0	14.8	AS	327B	23.2	13.0	BV	325B	20.7	8.6
J11-2 3-B	CT	5A	20.3	12.7	AS	1A2	21.7	14.5	BV	2A	17.8	8.6	CT	320A	20.1	12.2	AS	327A	22.4	15.2	EV	326B	16.2	7.3
J11-2 4-B	CT	5A	20.3	12.8	AS	1A2	21.8	14.7	BV	2A	17.8	8.6	CT	319B	17.3	11.2	AS	328A	23.8	15.1	BV	325A	21.4	9.8
* SPEAKER SEX FEMALE																								
J11-2 1-C	VW	6A2	17.3	7.9	KS	8A2	10.9	9.9	MP	8A	16.9	12.2	VW	305A	22.1	11.4	KS	314A	12.0	8.7	MP	321B	21.1	12.1
J11-2 2-C	VW	6A2	17.2	7.7	KS	8A2	10.8	9.8	MP	8A	16.8	12.1	VW	306B	19.8	12.7	KS	313B	11.9	8.9	MP	322B	18.4	11.0
J11-2 3-C	VW	6A2	17.2	7.5	KS	8A2	10.8	9.9	MP	8A	16.9	12.1	VW	306A	21.5	13.9	KS	313A	13.6	7.3	MP	321A	21.4	13.4
J11-2 4-C	VW	6A2	17.3	7.7	KS	8A2	10.8	9.6	MP	8A	16.9	12.1	VW	305B	22.1	13.0	KS	314B	10.9	6.8	MP	322A	20.7	9.6

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